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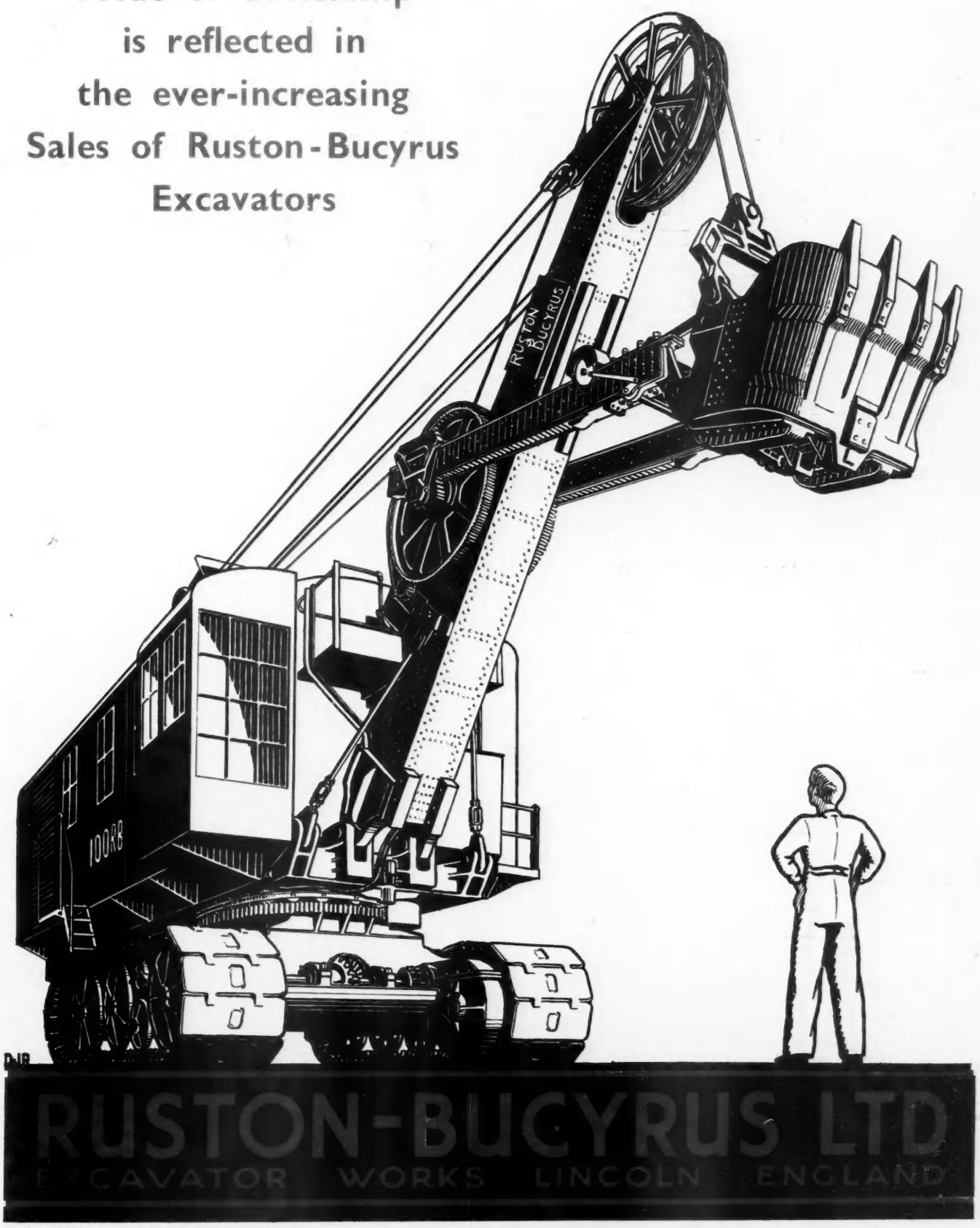

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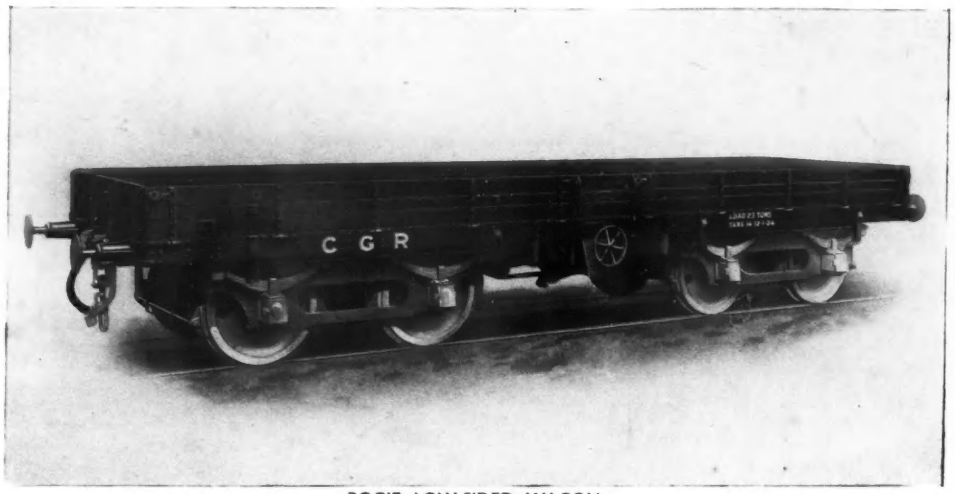

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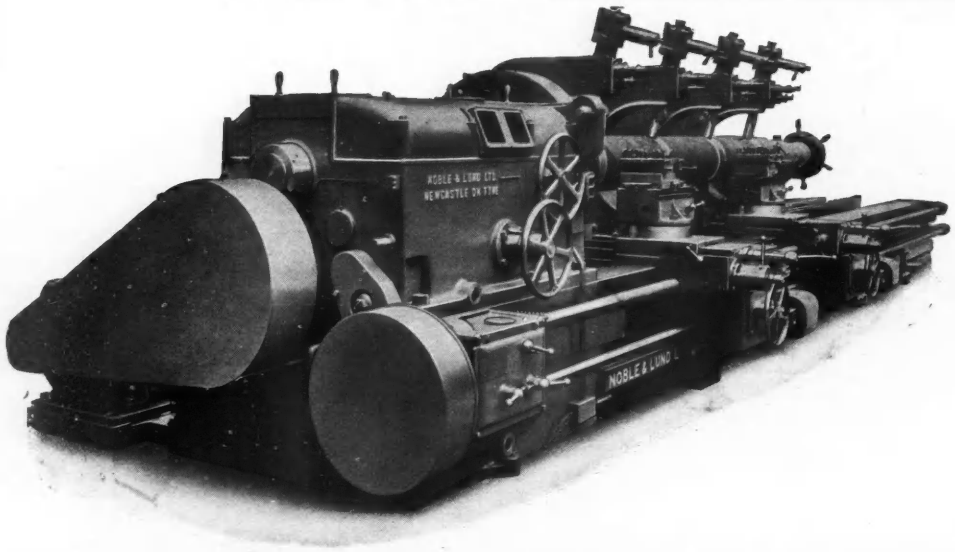

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A Dominion Aircraft Order.

The de Havilland Aircraft Company has announced the receipt of a large order for commercial aeroplanes from New Zealand. It consists of five multi-engined machines with an aggregate capacity of sixty-four passengers for the Union Airways and Cook Strait Airways. Three D.H. 86 four-engined express air liners will be provided for the Union Airways and two "Dragon Rapides," twin-engined eight-passenger biplanes for Cook Strait Airways. Thanks to the assistance of the Union Steamship Company of New Zealand, these two companies intend to run a series of regular air services on important routes covering several hundred miles. The D.H. 86 machine has a maximum speed of 173 m.p.h., and a cruising speed of 147 m.p.h. The ceiling on full power with full load is 19,000ft., and on three engines 13,500ft. With two engines cut out, both on the same side, the machine can still reach 2500ft. with full load. The D.H. 86 machines will operate a daily service between Palmerston North and Dunedin, *vid* Blenheim and Christchurch, connecting with the Auckland express at Palmerston. The "Dragon Rapides" have a full load ceiling with one engine of 4500ft. and on full power the rate of climb is about 1000ft. per minute. They will be used on a daily service between Wellington, Blenheim, and Nelson. Great importance has been attached to the climbing powers of these machines, owing to the mountainous nature of the country, with aerodromes situated at high altitudes, and to the climatic conditions which necessitate a large margin of horse-power.

The Late Mr. C. E. Stromeyer.

Boiler engineers and steam users have lost a leading engineer who did much to develop that branch of industry by the death of Mr. Charles Edmund Stromeyer, which took place at Bad Nauheim, Germany, on Tuesday last week. Mr. Stromeyer was seventy-nine years of age, and for over thirty years he had occupied the position of chief engineer of the late Manchester Steam Users' Association. He was born at Sutton in Surrey, and after serving his apprenticeship in a London engineering works, studied and took his degree at Aix-la-Chapelle. After some years at Tyne shipyards and at sea, he was in 1880 appointed an engineer surveyor by Lloyd's Register of Shipping. He had an inborn capacity for investigation and research work, and his contributions to such subjects as the stressing of plates and fatigue in metals were marked by originality and careful thought. In 1897 he became the chief engineer of the Manchester Steam Users' Association, a position which he held with honour until his retirement after over thirty years of service. His annual reports to his Association were instructive and interesting documents. During the war period he had an exacting task to examine and report on the safety of second-hand boilers, which would not have been worked except for war needs. He was a valued member of the Institution of Civil Engineers, the Institution of Mechanical Engineers, and the Institution of Naval Architects, and was also a member of the Iron and Steel Institute. In Manchester he took an active part in the work of the Manchester Association of Engineers, and became its President; he was also a past-President of the Manchester Literary and Philosophical Society. He was well known at institution meetings and international congresses, and made many contributions to discussions. His very practical book on "Marine Boiler Management and Construction" is regarded as a standard work of reference.

Institute of British Executives.

Almost two and a half years ago Mr. Ronald Ogden founded the British Executive Employment Society, with the object of assisting unemployed men of executive status into employment, and during this period the Society has had the valuable assistance of large business organisations and charitable trusts, and has achieved considerable success in its task. With the visit of His Royal Highness the Duke of Kent to the Institute last week to open the new library and club-room at Swan House, 133, Oxford-street, W.1, the inauguration of a further stage in the development of this work was begun. As the newly adopted name "Institute of British Executives" indicates, the scope of the work has now been widened to embrace all executive men, whether employed or unemployed. In his speech the Duke of Kent emphasised this wider scope, and referred to the future aim of the Institute, which would, he expressed the hope, become a representative organisation to deal with all problems affecting executive men as a whole. His Royal Highness also mentioned that the Institute was particularly interested in the representation of British firms overseas. He stated that it had on its register engineers and business men of all kinds, who had gained experience in every country in the world and knew the languages of those countries and the mentality of their peoples. Was it not worth while, the Duke asked, for firms who might wish to increase their overseas trade to get in touch with the Institute and arrange to meet these men?

Naval Limitation.

An important statement on the British Government's views on naval limitation was made in the House of Lords on Monday evening, July 29th, by the Marquess of Londonderry. Replying to a question put by Viscount Cecil, he said that during the conversations with the United States and Japanese representatives, beginning in October, 1934, the United Kingdom Government reached the conclusion that it would not be possible to make any agreement in replacement of the Washington and London Naval Treaties, which contained an expression of the principle of ratios of naval strength. In the opinion of His Majesty's Government, the only hope of preserving some form of quantitative limitation lay in eliminating from any future treaty figures which appeared to constitute a ratio as between the various signatory Powers, and to substitute for existing treaty engagements on this point a system under which each Power would make a voluntary and unilateral declaration of its construction programme for a period of years, say, 1937–42. It was proposed that these declarations should not have the force or form of contractual obligations. Nevertheless, the construction figures appearing in the programmes would require to be concerted beforehand between the Powers, and it would further be necessary that each Power should undertake in its declaration not to modify its announced building programme without giving previous notice of, say, at least one year, to other Powers making similar declarations.

The World Power Conference.

At the annual meeting of the International Executive Council of the World Power Conference, which took place in Holland on Wednesday, July 17th, at the Royal Netherlands Institute of Engineers, Sir Harold Hartley, the Chairman of the British National Committee, was elected by the Council as its Chairman. Sir Harold succeeds the late Mr. D. N. Dunlop, who occupied these two positions from the beginning. The World Power Conference was, we may recall, founded in 1924 to form a link between the different branches of power and fuel technology on the one hand, and between engineers, administrators, scientists and economists on the other. This wide basis is represented in the National Committees of no less than nearly all the forty-nine member countries. The choice of Sir Harold Hartley seems peculiarly appropriate, since, as a vice-president of the L.M.S. Railway Company and its director of research, he is in closest touch with industrial problems, while as the Chairman of the Fuel Research Board and a Research Fellow of Balliol College, Oxford, he is also in direct touch with scientific work. The Chemical Engineering Congress of the World Power Conference is to be held in London in June next year. The scope of that Conference will embrace chemical engineering projects and plant construction with its general problem of fuels, heat, &c.; while administration and works organisation problems and trends of development are to be dealt with.

A Novel Mine-laying Cadet Ship.

The Norwegian mine layer and cadet training ship, "Olaf Tryggvason," has just concluded an official visit to Liverpool in the course of her summer training voyage under Commander A. Jorgensen. She is returning to her home port, Horten, after visiting Brussels, Lisbon, Bilbao, and Brest. The propulsion of the ship is of interest in that a combination of turbine and oil-electric drive is used. For economical cruising, two airless injection, four-stroke, eight-cylinder, single-acting, Sulzer type engines, driving 560-kW, 250-volt generators, are employed to operate the two 700 b.h.p. propulsion motors at 190 r.p.m. Each motor is provided with independent reversing, as well as field regulation allowing the 700 b.h.p. to be delivered over a wide speed range. When full speed is required, two De Laval impulse type steam turbines are brought into operation on the same shafts through reduction gearing. The turbines run at 280 r.p.m., and develop together 4600 b.h.p. Astern turbines are incorporated. The turbines carry the shaft speed up from 190 r.p.m., equivalent to 15 knots, to 315 r.p.m. Reduced power is applied to the electric motors from 190 to 280 r.p.m., while from 280 to 315 r.p.m. full power of both systems is used. When the turbines are not in operation the speed and manœuvring is controlled from the bridge, but under full power the engine-room controls are used. Full electric auxiliary equipment is provided, and includes four oil engine-driven generators, totalling 270 kW.

Industrial Health.

The fifteenth annual report of the Industrial Health Research Board of the Medical Research Council was published on July 29th, and included a special report entitled "The Physique of Man in Industry." The latter report was compiled from the examination results of 13,656 male volunteers, aged fourteen years and upwards. These consisted of 10,593 men employed by 149 firms in England and Scotland, 1828 unemployed men, and 1735 students. The figures obtained are of interest to engineers, one example being the fact that the correct height for a work bench, based on the average elbow height, should be about 38in. Definite figures show the loss of physique in unemployed men when compared with their colleagues in the same area who are in work, though whether this is due to lack of opportunity to maintain physical development or not was not determined. The general report gives some definite figures as to "accident proneness" in all classes of humanity. In every occupation examined by the Board it was found that roughly three-quarters of the accidents occurred to one-quarter of the people exposed to the same risk. This applies to such unpredictable accidents as that of a piece of grit entering the eye, while the same rule is found to hold in motor car accidents and industrial mishaps. Incidentally, this "accident proneness" in the case of motoring applies equally well to accidents in which the observed driver was not considered to be to blame. Interest also attaches to the figures as to the harmful effects of noise and other unpleasant conditions arising in works and to their effect on output, both of quantity and quality of goods.

A New Humber Bridge Scheme.

We have already referred in these columns to the Humber bridge scheme of 1930 and the revised scheme of 1933, the Bill for which was withdrawn from the House of Commons in February of that year. A new scheme is, we are given to understand, now in preparation, and the Hull City Council is to be advised by its Parliamentary Committee to spend not more than £500 on the preparation of a detailed engineering report on it. In connection with its new scheme the Corporation has consulted Mr. Ralph Freeman, of Sir Douglas Fox and Partners, Westminster, who, it will be recalled, was associated with the Sydney Harbour Bridge and designed the Humber bridge which was included in the 1930 scheme. The bridge now proposed will have a single span of more than 4000ft., which will be, if built, the largest single span of any bridge in this country, and quite near the 4200ft. span of the new bridge at San Francisco, which is claimed to be the longest of its kind in the world. The proposed report is being drawn up for submission to the Minister of Transport, who has intimated that before he can consider the project fully from the point of view of making a grant, a detailed engineering report will be required.

British Commercial Policy.

The Federation of British Industries has just published its survey of British commercial policy since the construction of a British protective tariff, the measures taken for the rehabilitation of British agriculture, the conclusion of the Ottawa agreements, and the negotiations of trade agreements with a number of non-Empire countries. From its survey of the position the main conclusion drawn is that our commercial policy, taken as a whole, has secured a remarkable degree of economic recovery, with increased home and export markets. The survey suggests that the best course for Great Britain is to continue and to extend the policy which His Majesty's Government has pursued with such success during the last few years. Three further points with regard to our commercial policy are, the survey says, outstanding, first, that industrial protection has been a success; secondly, that the results of the Ottawa agreements have been to increase inter-Imperial trade, although so far the overseas Dominions have reaped greater benefits than has the United Kingdom; and thirdly, that the trade agreement countries have been the most satisfactory of our foreign customers. The survey strongly urges that, in view of the importance of the British market, the grant of "most-favoured-nation" treatment should not be included more or less automatically in any treaties with foreign countries, but should be regarded as a very valuable concession by this country requiring an adequate and substantial *quid pro quo*.

A Greenock Shipyard Sale.

It is announced that Harland and Wolff, Ltd., have sold the Greenock shipyard, formerly owned by Caird and Co., to National Shipbuilders Security, Ltd., which will keep it on a care and maintenance basis. The firm will continue to concentrate its Clyde shipbuilding activities at its Govan yard, in accordance with the practice of recent years. The Greenock shipyard, popularly known as Caird's yard, is one of the oldest on the Clyde, with a history extending over a century, and a close association with the P. and O. fleet. Between 1835 and 1916 close on ninety vessels were built on its stocks, the contracts aggregating over 500,000 tons and being valued at over £11,000,000. In 1916 the shipyard was acquired by Harland and Wolff, which firm made large extensions, in the course of which it was obliged to remove the old West Kirk and graveyard, where Robert Burns's Highland Mary was buried, to new sites. The shipyard was badly affected by the slump and the last launch took place from it in 1928.

British Railways as a National Asset.

No. 1.

THE SIZE OF THE UNDERTAKING.

BRITISH railways, in the amount of money invested in them and in the business they do, form the largest commercial undertaking in the world. That fact becomes more pronounced when it is remembered, first, that they are wholly a private enterprise, both as to their construction and as to their operation, and secondly, that a good 98 per cent. of their created capital and of their business is in the hands of the four main line—or grouped—companies. The part that British railways play in the financial, commercial, and public life of the country may be judged by a few sample figures.

The capital expenditure at the end of 1933—the last year for which complete figures are as yet available—was £1174 millions. The amount appropriated for the payment of interest and dividends that year was nearly £31 millions, which represents 2·76 per cent. upon the total capital receipts. For the commerce of the country they carried 251 million tons of freight, of which 165¼ million were of coal, coke, and patent fuel, and workmen made 200 million journeys. They purchased for use on the railway material to the value of £35 millions, and burnt £11 millions worth of coal in their locomotives. On printing, advertising, stationery, and tickets, the sum of £1¼ millions was spent, and 195,000 tons of rails were bought for use in the track. For the commercial world and the public generally the railways carried mails and parcels post to the carriage value of £4 millions, and newspapers of a corresponding value of £2¼ millions. During 1933, 800 million passenger journeys were made. Excluding those engaged in locomotive, carriage, wagon, and other manufacturing and repairing shops, there were 566,000 railway servants, to whom £100 millions were paid in salaries and wages. Our railways, therefore, contribute very deeply to the national welfare in many respects.

The railways are affected by the general prosperity of the country. The adverse influence of the recent trade depression may be seen in the fact that the gross receipts of the four main line, or grouped, companies from railway working—the term which covers the railways proper and excludes the subsidiary businesses of steamboats, docks, hotels, &c.—dropped from £198·9 millions in 1923 and £196·3 millions in 1924, and even £184 millions in 1929, to £143·9 millions in 1932. That is a fall of 27·64 per cent. in ten years, but, despite a reduced expenditure, the net receipts, when comparing the £23·2 millions of 1932, with the £37·4 millions net receipts of 1923, fell by 37·94 per cent. Expenditure on a railway can only be reduced gradually.

THE SIZE OF THE UNDERTAKING.

That there was not a greater loss on the railways during the last four or five years has been of material benefit to the country generally. But for the ability of their administrators and, as we shall show, in particular of their engineers, the loss would have been much greater. That misfortune would have reacted on the value of the railways as an investment; would have restricted their operating efforts and adversely affected the facilities for the conveyance of freight and passengers; reduced their expenditure on works and the purchase of material, and, of no small moment, would have compelled a reduction in the labour costs.

Some idea of the stake held by the railways in the finance of the country may be seen in there having been, by the end of the year 1933, £1174 millions expended on capital works. The railways have many subsidiary interests—known in official circles by the less simple term of "ancillary businesses"—such as road transport, steamboats, canals, docks and harbours, hotels and refreshment rooms. The official term given to railway business proper is "railway working," and the capital expended therein was £1009 millions. The amounts for the subsidiary businesses were:—Road Transport, £6 millions; steamboats, £9½ millions; canals, £8 millions; docks, harbours and wharves, £71 millions; hotels and refreshment rooms, £9½ millions. Of the £1009 millions capital expended by railway companies on railway working, £840 millions was for "the line," stations, bridges, buildings, signalling, &c.; £146 millions went on rolling stock, and £23 millions on manufacturing and repairing works and plant.

The amount paid in interest or dividend "after adjustment in respect of duplication," is shown in a summary in the Railway Returns for 1933. It was as follows:—Loans, £141,910, at an average of 2·13 per cent.; debentures, £319 millions, at 3·85 per cent.; rent charges, £10 millions, at 4·79 per cent.; guaranteed, £150 millions, at 4·22 per cent.; preference, £366 millions, at 2·61 per cent.; ordinary, £280 millions, at 0·76 per cent. The average was 2·74 per cent., and the amount paid out in interest and dividend was £31 millions. It may be added that in 1913 the amount of capital expended stood at £1141½ millions, and the average paid in interest and dividend was 3·62 per cent.

As assets for the capital expenditure on railway working the companies had, at the end of 1933, 20,116 miles of railway—known as route miles—on which 37,001 miles of track—known as track miles—were laid. Of the 20,116 route miles, 7655 had only one track, *i.e.*, were single lines. There were 15,638 miles of sidings.

The steam locomotives numbered 20,983, divided as 12,673 tender engines and 8310 tank. Additionally, there were 13 electric locomotives, 9 petrol locomotives, 1489 electric rail motor vehicles, and 160 rail motor vehicles, other than electric. There were 41,883 carriages for steam trains, and 1537 trailer electric stock. There was a total seating capacity of 2,588,961, or an average of 57·44 seats per vehicle. Included in the passenger stock were 666 restaurant cars, on which, incidentally, over 8,000,000 meals a year are served. There were also 225 Pullman cars, with a total of 6432 seats.

The number of wagons of every kind was 633,605. Of the 582,555 ordinary wagons, both open and covered, 4908 were of under 8 tons capacity, 73,596 of between 8 and 10 tons, 188,675 of 10 tons and under 12 tons, 266,330 of 12 tons, 20,532 of over 12 tons and under 20 tons, and 28,514 of 20 tons and over. There were 51,050 "special" wagons, *e.g.*, the high-capacity wagon, for the conveyance of the companies' locomotive coal, also bricks, &c.; 18,525 cattle trucks, and 23,289 rail and timber trucks.. The total capacity of the wagons was 7,286,991 tons, and the average per wagon was 11·501 tons.

Engaged in the collection of parcels and goods traffic were 6552 motor and 27,786 horse-drawn vehicles. There were 14,506 horses for the horse-drawn vehicles, also 484 horses for shunting wagons.

There are 6761 passenger stations and 10,500 signal-boxes. The land owned by the companies covers 37,000 acres and they possess 56,000 houses. Rents from houses and lands produced £2½ millions in 1933.

As assets for the £9½ millions expended on steamboats there are 147 vessels with a net registered tonnage of 77,222. For the £8 millions on canals, there are thirty-four canals, of a total length of nearly 1000 miles; on the building and equipment of docks harbours, and wharves, where £71 millions have been expended, there is a quayage length of 513,273ft., and the hotels, on which £9½ millions have been spent, are eighty in number.

The railways employ 566,000 servants in all departments—on the railway proper and in the subsidiary businesses—other than in the locomotive, carriage, wagon, and engineering workshops. These ranks include 32,000 drivers and motormen, 30,000 firemen, 7340 passenger guards, 13,000 goods guards, 16,000 shunters, 25,500 signalmen, 23,000 passenger porters, 13,000 goods porters, 55,000 permanent way men, 6000 signal and telegraph linemen, 20,000 labourers of all classes, 5300 stationmasters, and 65,000 officers and clerical staff. There are nearly 9000 females engaged on clerical and technical work. On the docks there are 11,500 men employed, 4000 on the steamboats, 3700 in the marine department on shore, and 7200 males and 5500 females in the hotels, refreshment rooms, &c. About £100 millions a year are spent in salaries and wages for the staff employed on the railways.

Perhaps the outstanding feature to indicate the financial standing of and the business done by British railways is to be found in the general balance sheet of the Railway Returns. The assets are put down at over £173½ millions, and the table opens with the item of £58 millions spent on capital works in excess of the capital received. Cash at bankers and in hand represents £20½ millions, and investments in Government securities £40½ millions, whilst investments in other companies, not charged to capital expenditure, amount to £7 millions, of which transport undertakings are credited with £6 millions. The value of the stocks of stores and materials is put down at £15½ millions, and outstanding traffic accounts at £12 millions. The amounts due through the Railway Clearing House were £1,400,000, and what are described as "accounts receivable" give £2¾ millions. The companies have advanced £3 millions to building societies and to the staff for houses; miscellaneous accounts are put down at £10½ millions, and suspense accounts at £2 millions.

The liabilities were £162 millions. One of the first items met with is that of £4¾ millions for interest and dividends payable or accruing, and provided for. The £820,000 shown as "amount due to railway companies and committees" is a sum that was £18,490 in 1928 and has grown year by year from £602,794 in 1929, and we suggest that it represents the amounts that have to be pooled under terms that had not been agreed to by the end of the year. The companies have three large liabilities in relation to their staff. The savings bank sums deposited with the railways amount to £21½ millions, and they also hold nearly £45¾ millions contributed to superannuation and provident funds—of the latter, nearly £5 millions are invested—and £10¾ millions reserved for superannuation and pensions. The accounts payable to the companies are placed at £7½ millions, the "liabilities accrued" at £4 millions, and miscellaneous accounts at nearly £5 millions. The fire insurance funds amount to nearly £2¾ millions, the steamboat insurance to nearly £1 million, and the compensation for accidents fund to £350,000. Finally, there are £62½ millions in what are, in effect, reserve and renewal funds. These are:—Improvements fund, £1¾ millions; works and equipment maintenance fund, £800,000; way and works renewal fund, £15½ millions; rolling stock renewal fund, £15¼ millions; other renewal funds, £6½ millions; steamboat renewal funds, £5¾ millions; fund for renewals in other subsidiary business, £10½ millions; contingency fund, over £2¾ millions; general reserve fund, over £3½ millions. The balance available for dividends and general reserve, after deducting the interim dividends, was £11¾ millions.

THE BUSINESS DONE.

The number of passenger journeys, including those by workmen and season-ticket holders—the journeys of the latter are reckoned as 600 a year for each holder—made on British railways in 1933 was over 1100 millions. Of this number, there were 46 millions by first-class passengers and 207½ million journeys by workmen. Season-ticket holders were 600,000 in number. The receipts from passengers, other than season-ticket holders and workmen, were £40 millions; season-ticket holders furnished nearly £8 millions; and workmen, £3 millions. First-class passengers produced an average of 5s. 3·66d. per journey; workmen, 3·57d.; and the average fare paid per ordinary passenger was 1s. 4·32d. Parcels brought in £12½ millions, the mails and parcels post nearly £4 millions, and the gross receipts from passenger traffic were nearly £67½ millions. Passenger traffic furnished 45·06 per cent. of the total receipts from railway working.

The extent to which railway companies give reduced fares in the way of cheap day, monthly return, tourist tickets, &c., may be judged from the fact that of the passenger journeys made, other than those of season-ticket holders and workmen, only 16·57 per cent. were at full fare and these produced 21·88 per cent. of the receipts from those passengers.

During the year 1933 the freight traffic conveyed amounted to 269 million tons, of which 46 million tons were of general merchandise, 46 million tons of minerals and of merchandise in classes 1 to 6, and 177 million tons of coal, coke, and patent fuel. The number of the livestock carried was 11 million. The average distance the total freight traffic was conveyed was 55·78 miles; the average distance for the above three headings of traffic was 99·30, 61·98, and 42·87 miles respectively, The total net ton-miles for each heading was:—Merchandise, 4558 millions; minerals and merchandise in classes 1 to 6, 2869½ millions; coal, coke, and patent fuel, 7590 millions. The freight traffic receipts amounted to £80¾ millions, made up of:—General merchandise, £37½ millions; minerals and merchandise in classes 1 to 6, £11½ millions; coal, coke, and patent fuel, £30¼ millions; livestock, £1¼ millions. The average receipt per ton of all freight traffic was 6s. 4d., and for the first three of the above headings was 17s. 8¾d., 5s. 5d., and 3s. 7¾d. respectively. The average receipt per ton-mile was 1·373d., and for the same three headings it was 2·097d., 1·021d., and 1·046d. respectively. The freight traffic produced 54·00 per cent. of the total receipts.

THE COST OF THE WORK DONE.

The railways proper cost, in 1933, £123 millions to run. Included in that figure were £17½ millions for maintenance and renewal of way and works, £20 millions for the maintenance and renewal of rolling stock, £30 millions for locomotive running, £43 millions for traffic expenses, £5 millions for general charges, and £5 millions for rates—£1,300,000 actually paid and £3,800,000 given in freight rebates for rate relief.

The expenditure was 82·28 per cent. of the total receipts from railway working; the main items of expenditure were:—Way and works, 14·20 per cent.; rolling stock, 16·34 per cent.; locomotive running expenses, 24·41 per cent.; traffic expenses, 34·84 per cent.; general charges, 4·17 per cent.; rates, including freight rebates, 4·20 per cent.

The first item to appear in the expenditure accounts is for the maintenance of way and works. In passing, attention may be drawn to those delightfully simple, and so typically English, words "Way" and "Works." The former refers to what we already have referred to as "the line," *i.e.*, the track along which the trains run—known as the "running line"—the junctions by which they pass from one line to another, the sidings on which vehicles stand when not on the running lines, and the connections between the running lines and the sidings. The "works" are the bridges, viaducts, tunnels, stations, goods sheds, locomotive depôts, carriage sheds, &c.

The account for the maintenance of way and works opens with the salaries and office expenses for superintendence. They absorbed £1,140,000 in 1933. Then comes the upkeep of roads, bridges, and works to the amount of £2,200,000, whilst the maintenance of stations and buildings absorbed £2,100,000. What

we have called "the line" is officially the permanent way, and its maintenance cost £7¼ millions, whilst on the renewal of the track nearly £3 millions were spent in 1933. Signalling, telegraphs, and telephones, and the maintenance of electric track equipment come under separate headings. The first took £1¾ millions, the second £500,000, and the last £100,000. The Railway Returns give some particulars as to the amount of material used in the maintenance and renewal of the permanent way. These were :—Ballast, 1,800,000 cubic yards ; rails, 175,000 tons ; sleepers, 3,500,000. The amount of track renewed was 1142 miles. Maintenance of way and works absorbs 14·20 per cent. of the total expenditure of railway working.

The maintenance and renewal of rolling stock during 1933 was returned as £20 millions, or 16·34 per cent. of the total expenditure. Actually it was less than £20 millions, as that sum included £1,200,000 put to reserves. Superintendence and office expenses needed £860,000. The complete renewal of locomotives cost £960,000 and their repair and partial renewal £8,000,000. For that sum 222 locomotives were renewed, 6842 heavily repaired, and 6284 received light repairs. These three sets of figures, by the way, represented 1 per cent., 32·6 per cent., and roughly 30 per cent. of the total number of locomotives owned. The sum of £66,000 was spent on the complete renewal of rail motors used in electrical services, of which all but £1525 was paid to contractors. The repairs to and partial renewal of that class of vehicle amounted to £311,000. The complete renewal of coaching stock, other than steam and electric rail motors, cost £1¼ millions and their repairs £3¼ millions. Wagon renewals absorbed £765,000 and their repairs £3,276,000. During the year 6500 wagons were renewed, 52,000 had heavy repairs, and there were 1,230,000 instances of light repairs.

The locomotive running expenses are no longer considered to be an engineering responsibility, but are viewed as part of the operation of the railway. So much so is that the case that in the standard form of accounts locomotive running expenses and traffic expenses are first given separately in a minor column and then have a total for both of them in the main column. The locomotive running account contains some items that throw an interesting light on the cost of operating a railway. Taking the figures for the year 1933, we find, after £720,000 on salaries and office expenses, that £16¼ millions were paid out in wages for running the steam locomotives and £338,000 for the electric locomotives. Fuel took no less than £10 millions, whilst other items were :—Water, £760,000 ; lubricants, £220,000 ; other stores, including clothing, £395,000 ; and there was the sum of nearly £280,000 under miscellaneous.

The steam locomotives consumed 52·41 lb. of coal per engine mile and 6·19 pints of lubricating oil for every 100 miles. The electric motor vehicles consumed 5·67 low-tension units per vehicle mile and 4·60 pints of oil for lubricating purposes per 1000 vehicle miles. We would add that we give the last two items as they appear to be called for when giving the steam locomotive figures, but the electrical figures are hardly comparable, as they include the railways now under the London Passenger Transport Board, which is not the case with any of the other figures we have given, at any point in the present article.

Resuming and concluding consideration of the locomotive running expenses, it has to be noted that the items for wages, fuel, water, oil, stores, &c., totalled £28,300,000, which, we would observe, is £1350 a year for running each steam locomotive. The current for operating the electrically propelled trains —herein the L.P.T.B. is excluded—cost £1,100,000. Locomotive running expenses comprise 24·41 per cent. of the total expenditure.

Traffic expenses are the heaviest item in railway operation. Their share is 34·84 per cent. of the total expenditure and so they cost more than twice as much as the upkeep of the rolling stock ; in fact, if locomotive running and traffic expenses may be considered as the earning power of a railway they cost 60 per cent. of the total expenditure of the business.

The total for traffic expenses in 1933 was £43 millions. Included therein was £3 millions for superintendence and then no less than £31 millions for five classes of men : station-masters and clerks, £9½ millions ; signalmen and crossing keepers, over £4½ millions ; ticket collectors, policemen, porters, &c., £10½ millions ; guards, £3½ millions ; shunters, £3 millions. Under this heading of traffic expenses are even more numerous items of interest than in the account for locomotive running. Fuel, lighting, water and general stores—not for locomotives, it will be understood—cost £1,300,000 in 1933 ; clothing, £330,000 ; printing, advertising, stationery, stamps, and tickets, £1,300,000 ; cleansing, lubricating, and lighting of vehicles, £1,600,000 ; working of stationary engines, hoists, cranes, &c., £745,000 ; commission to passenger ticket agencies, £245,000 ; transshipment by road vehicles, £1,700,000. The last, which is the intermediate labour cost that comes between the transport by rail and the collection or delivery of the traffic, is a comparatively new item. It first appeared in the accounts for 1928 under an Order—the Railway Companies (Accounts and Returns) Order—dated December 27th, 1928, made by the Minister of Transport, partly as a result of the road powers given to the four main line companies in that year.

Under the heading of general charges nearly £5¾ millions, or 4·17 per cent., of the total expenditure were spent. That item is noteworthy in that it reveals that the fees paid to the directors were, in 1933, exactly £100,000. The salaries of the secretary, general manager, accountant, and of their clerks, together with the office expenses, amounted to £1½ millions. The only other large amount in this account is the £3½ millions as the companies' contribution towards their servants' superannuation and benevolent funds, pensions, &c.

The accounts of the subsidiary businesses provide some instructive items, especially as each shows the income as well as the expenditure. Road transport —that is, the companies' own road transport—cost £458,000, but as it earned £539,000—£270,000 of which was from passengers and £265,000 from goods—there was a profit of £81,000. Steamboats cost £3 millions and made a profit of £209,000 ; passengers therein produced £1½ millions, and goods £1 million. The receipts from the steamboats do not, however, end there. The L.N.E.R. Review of the company's business for 1933 observed that in estimating the value of the steamboat services it is necessary to take into account the railway receipts on traffic derived from those services. For the year 1933 these were estimated at £379,835, of which the Harwich and Continental services provided £273,415. Canals, on the other hand, made a loss. Their best source of income was a profit of nearly £73,000 from rents, whilst tolls furnished £68,500. Of the expenditure of £213,000, the maintenance of the canals absorbed £146,000.

Docks, harbours, and wharves brought in £6,350,000, or 11 per cent. on the capital outlay, of which over £2 millions were from dues on ships, goods, and passengers—the last was only £25,000 ; £764,000 was from the use of the railways on the docks, and nearly £2,400,000 from cranage and other services. Included in the total expenditure on docks of £5¾ millions were :—Maintenance of the docks, harbours, dock railways, cranes, hoists, tips, and buildings, nearly £1,200,000 ; operation of the dock railways, £1 million ; operation of cranes, hoists, tips, and other services, £1½ millions. There was thus a credit balance of £396,000 from dock undertakings.

The hotels, refreshment rooms, and restaurant cars made, in 1933, a profit of nearly £450,000. The gross receipts were over £5 millions, but there are no details as to how that amount was made up. Among the items of expenditure were :—Salaries and wages, £1 million ; provisions, wines, and spirits took over £2¼ millions ; rates, £120,000 ; and licence duty, £22,000.

The account for the collection and delivery of parcels and goods shows a loss of over £672,000. Goods train traffic produced £4 millions and passenger train traffic £356,000. On the expenditure side, additionally to £3¾ millions for traffic expenses, there were :—Maintenance of motor vehicles, £400,000 ; maintenance of horses, £848,000 ; maintenance of horse-drawn vehicles, £182,000 ; hired cartage, £840,000 ; licence duty, £200,000.

(To be continued.)

Activated Sludge Sewage Disposal Plant at Davyhulme.

ON Wednesday, May 15th last, extensions to the Davyhulme sewage works of the City of Manchester Rivers Department were inaugurated by the Lord Mayor. These extensions were first contemplated as long ago as 1912, when, in fact, a decision was made to provide a further system of primary and secondary contact beds similar to those already in existence at that time, and also to arrange for the installation of humus beds. The intervention of the war put a stop to work upon this scheme, and the position was not reviewed again till some time after the conclusion of hostilities. In the interval the activated sludge process of purification had made its appearance, and had been developed into a practicable and economical method of sewage treatment, and eventually, following upon detailed experiments with three large-scale plants for several years, it was decided by the Department to construct a plant for this process able to deal with about one-half of the dry-weather flow of 32 million gallons per day from a population of 775,000 people. By this means the existing contact beds, now treating only the remainder of the sewage, could be used up to their determined effective capacity, while, as compared with the original scheme decided upon before the war, there was such a great economy of space that it was unnecessary to acquire new land for the extension.

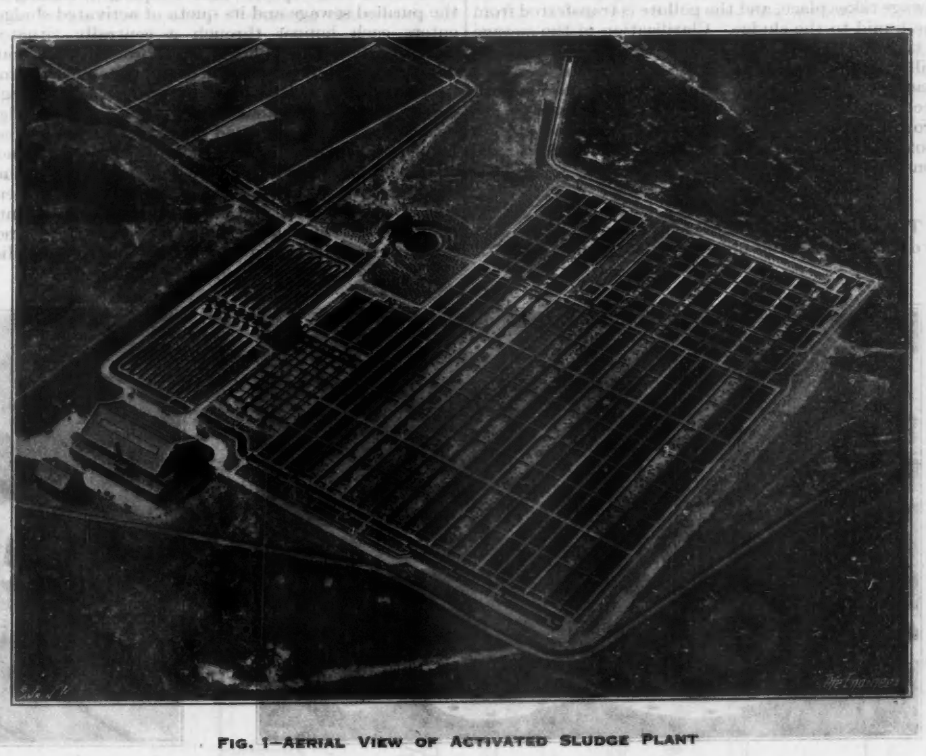


FIG. 1—AERIAL VIEW OF ACTIVATED SLUDGE PLANT

Three separate and distinct activated sludge units have therefore been installed—a "Simplex" unit to deal with 1,000,000 gallons a day, a "Bio-aeration" plant to treat 600,000 gallons a day, and a "Diffused Air" plant able to treat 16,000,000 gallons a day. Of these plants, as may indeed be gathered from its much greater capacity, the last named is the most important. In fact, the other two systems have been included in the extensions largely for experimental and comparative purposes, with a view to the probable need for further extensions at some date in the future. It is with the "diffused air" units, which were installed to the designs and under the supervision of Activated Sludge, Ltd., of Westminster, and their auxiliary compressor plant, that this article is mainly concerned.

There are several plants in this country treating sewage by the activated sludge process, which is therefore by no means novel. But it may be of interest shortly to recapitulate some of the essentials of the diffused air process, particularly as the compressor plant supplying the necessary air has to be designed to meet certain peculiarities of the system.

The main action takes place in aerating tanks through which there is a continuous flow of sewage, and in the bottom of which there are arranged special diffusers in the form, usually, of porous tiles. Through these tiles compressed air is caused to pass, and, being atomised in the process, rises in minute bubbles through the sewage. This aeration process is continued until the opalescent sewage begins to clarify, when it is found that a very small quantity of deposit collects if the liquid is allowed to settle. This deposit is the nucleus of the activated sludge, and it is usually

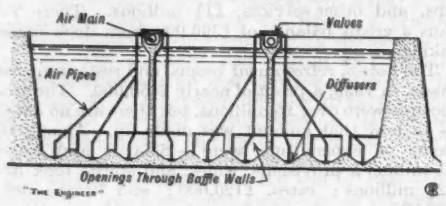


FIG. 2—AERATION TANKS

collected in separate settlement tanks through which the effluent continuously passes away. Part of the sludge and effluent thus collected is next passed through further aeration tanks for "conditioning," by which is meant the bringing up of the sludge to its fullest activity, and it is then returned into the stream of inflowing crude sewage. The amount of sludge it is necessary to return to the main aeration tanks in this manner in order to obtain the best results depends very largely upon the composition of the sewage. At the Davyhulme works experiments carried out up to date suggest that the sewage undergoing aeration should contain about 10 per cent. of sludge, measured after settlement for one hour. The actual mechanism of the process can, according to Activated Sludge,

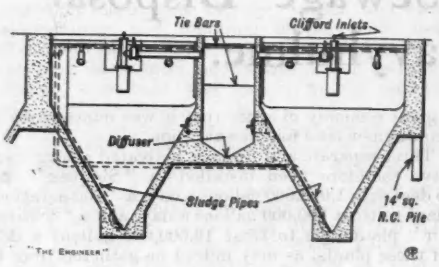


FIG. 3—SETTLEMENT TANKS

Ltd., be regarded as occurring roughly in two stages. Firstly, coagulation of the colloidal matter held in the sewage takes place, and the pollute is transferred from the liquid to the sludge. Clarification of the sewage is thus obtained to a large extent, but the pollute is still held practically unoxidised in the sludge. This reaction can be regarded as largely physico-chemical. Secondly, carbonaceous and nitrogenous matters are broken down and subsequently oxidised to carbon dioxide and nitrite and nitrate. This stage can be considered purely biological.

Air Diffusion Plant.

The actual plant installed at the Davyhulme works is divided into seven units, each 354ft. long by 47ft. wide by 15ft. deep, divided longitudinally into three channels, so that the total travel is 1062ft., and the tank capacity is about fourteen hours of dry-weather flow. Of these seven units, two are arranged to be entirely independent of the remainder, so that they can be used for experimental purposes; four are of normal design intended for steady operation; and the remaining one is used for the re-activation and conditioning of the returned sludge. All the tanks except the last mentioned are fed from a mixing channel, into which also the sludge is returned from the re-activation unit. The general arrangement of the tanks is well seen in the aerial view of the plant reproduced in Fig. 1, while an engraving on page 118 shows the plant in greater detail. After flowing through the aeration units the sewage passes to the settlement tanks to be seen beyond the aeration units in Fig. 1. On the left of the engraving there are also to be seen the compressor house for the diffused air plant and the "Simplex" and "bio-aeration" tanks.

The general construction of the aeration tanks is shown by the line engraving, Fig. 2. The air-diffusing tiles are screwed into cast iron trays and are placed in three longitudinal rows of grooves along the bottom of each channel. Compressed air is supplied to each tray through a separate pipe and needle valve. At intervals of 42ft. cross walls descend from above to within 3ft. of the channel floor, and at these points transverse lines of diffusers form curtains of air in front of the openings. The settlement tanks, the construction of which is shown in Fig. 3, are hopper-bottomed. There are sixteen of them for every single aeration unit, and they are each 20ft. square, and give three hours' detention of dry-weather flow, exclusive of sludge storage space. Mixed liquor, consisting of the purified sewage and its quota of activated sludge, enters each hopper through a centrally situated Clifford inlet, the effluent overflows through four adjustable bell-mouthed outlets and the sludge having been deposited is discharged hydrostatically through a pipe from the bottom. Both effluent and sludge outlets are readily adjusted for level. Eight of these hoppers are placed on each side of the mixed liquor channel from which they are fed, the latter being provided with diffusers to keep the sludge in suspension. The effluent and sludge are delivered into channels intersecting the hopper system, the former being passed through a gauging chamber before discharge to the Ship Canal, and the latter being returned to the sewage, *vid* the reconditioning tank or discharged through a measuring chamber to the surplus sludge well for disposal.

In passing through the various tanks, connecting channels and measuring chambers, the activated sludge loses about 3ft. of head and to enable it to complete the cycle it is raised by air lift pumps. These pumps are operated by the same air supply and pressure as the diffusers and are grouped in batteries. They are illustrated in Fig. 4. Two batteries, each of three 15in. lifts, take care of the sludge for the four combined aeration tanks, whilst two batteries, each of two 12in. lifts, meet the requirements of the two independent aeration tanks. The combined capacity of all the air lift pumps is about 20 million gallons of sludge per day. But actually a total of about 10 million gallons per day is sufficient for present requirements, so that not all of the units in each battery are in use. In order to allow for the variations in the required quantity which occur, according to the strength and quality of the sewage undergoing treatment, one lift in each battery is regulated by an automatic valve operated by a float-controlled auto-pneumatic pilot valve. Regulating the supply of air by these means enables the lifts to handle very considerable variations in the flow of sludge without any hand control, and to do it with greater precision.

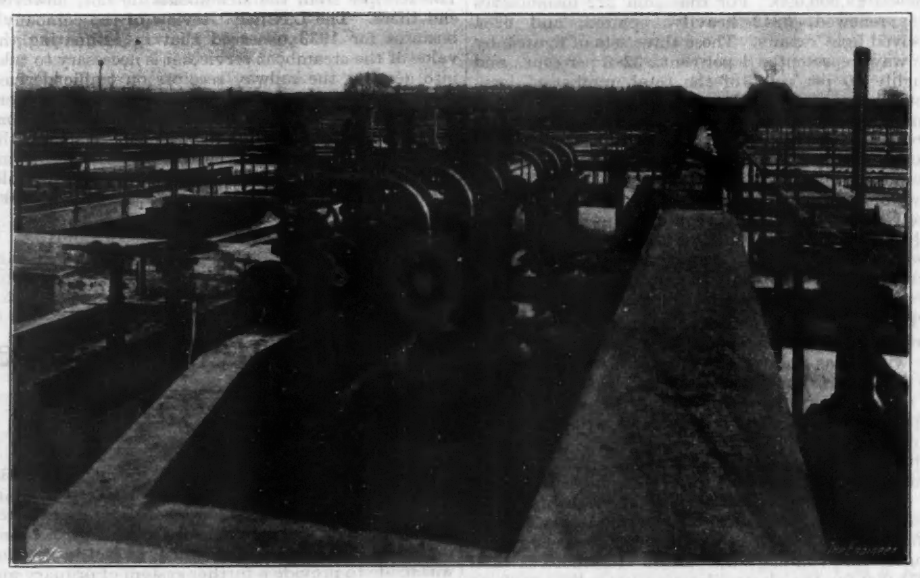


FIG. 4—AIR LIFT PUMPS

The Compressor Plant.

It will have been noticed from the foregoing description that the essential principle of the activated sludge process is that of aerating the sewage as it passes through the tanks. A large volume of air must therefore be supplied at a comparatively low pressure, and for this purpose three electrically driven turbo-blowers have been installed in the compressor house near the tanks. These blowers, which were made by Reavell and Co., Ltd., of Ipswich, are particularly interesting machines, not because there has been any great departure from ordinary practice, but because they operate at high efficiency under arduous conditions. Normally, the process of aerating the sewage calls for a pressure of the air between 8 lb. and 10 lb. per square inch, and, since in turbo-blower practice, an increase of pressure of 5 lb. per stage* is quite usual, a two-stage design was therefore called for. Under certain circumstances, however, the aerating tanks may call for an increased volume of air at a higher pressure than 10 lb. per square inch, and this fact, by introducing difficulties, has lifted the plant out of the ordinary run of every-day practice.

By adopting a three-stage design in order to obtain the pressure of 12 lb. per square inch desired, the blower machinery would not only have become more expensive in first cost, but at the ordinary working

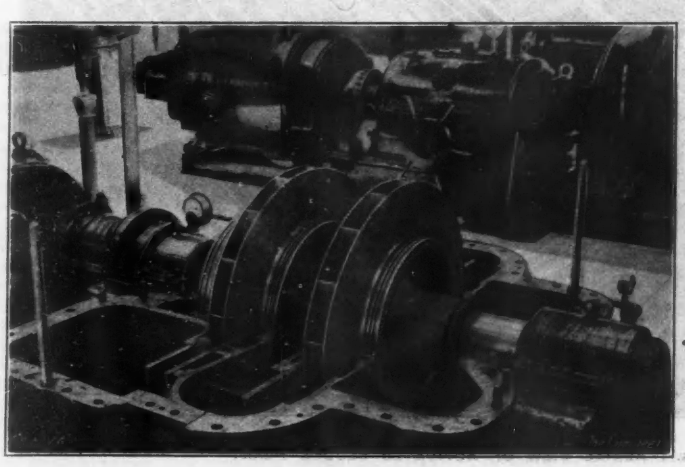


FIG. 5—TURBO-BLOWER WITH COVER REMOVED

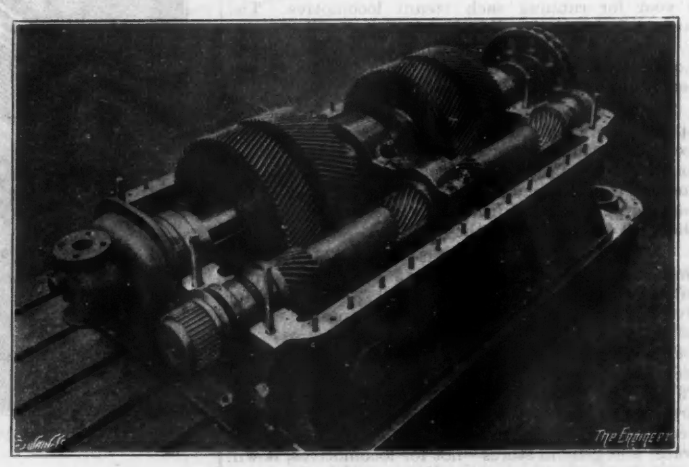


FIG. 6—FOUR-SPEED GEARBOX

* Actually, of course, pressure ratio is the factor concerned. The figure given is, however, approximately correct for the particular class of machine under discussion.

conditions would not have been operating at the highest efficiency. Consequently, a successful attempt was made to design a two-stage machine capable of delivering against the desired maximum pressure. In addition, those who are conversant with turbo-blower design will recognise that a constant-speed machine of this type cannot be made which will give an increased delivery against a greater pressure. In fact, the characteristic of a turbo-compressor, like that of a centrifugal pump, is such that the volume delivered becomes less as the delivery pressure rises. To meet the required conditions, therefore, it was necessary to make provision for varying the speed of the turbo-blowers, and it was eventually decided to interpose between the A.C. driving motors and the blowers gear-boxes giving a choice of four speeds.

In general design, all three compressors are similar. Two are of 10,000 cubic foot capacity and one of 15,000 cubic feet. One of the smaller machines was the first to be made, and as a result of tests carried out with it, minor modifications were made in the other two. A view of the larger turbo-blower with its top cover removed is reproduced in Fig. 5, the sectional drawing, Fig. 8, shows the design in greater detail, and an engraving on page 118 is a reproduction of a photograph of the three units installed in the compressor house. In general, each machine conforms to the usual Reavell design, the unusual performance being obtained by modifications of detail. Impellers are built up of two high-tensile nickel-chrome steel forgings machined all over, between which are riveted the 3 per cent. nickel steel hardened and tempered blades. To ensure freedom from vibration, the shaft upon which the impellers are mounted is carefully balanced as each individual impeller is fitted to it. Force-lubricated journal bearings, white metal lined, carry the shaft. Although the end thrust is largely taken up by the balance piston fitted to the shaft, a Michell double-thrust bearing is included to take up any, in either direction, that may remain. The cast iron casing is so designed that the top half can be removed without disturbing the suction and delivery connections.

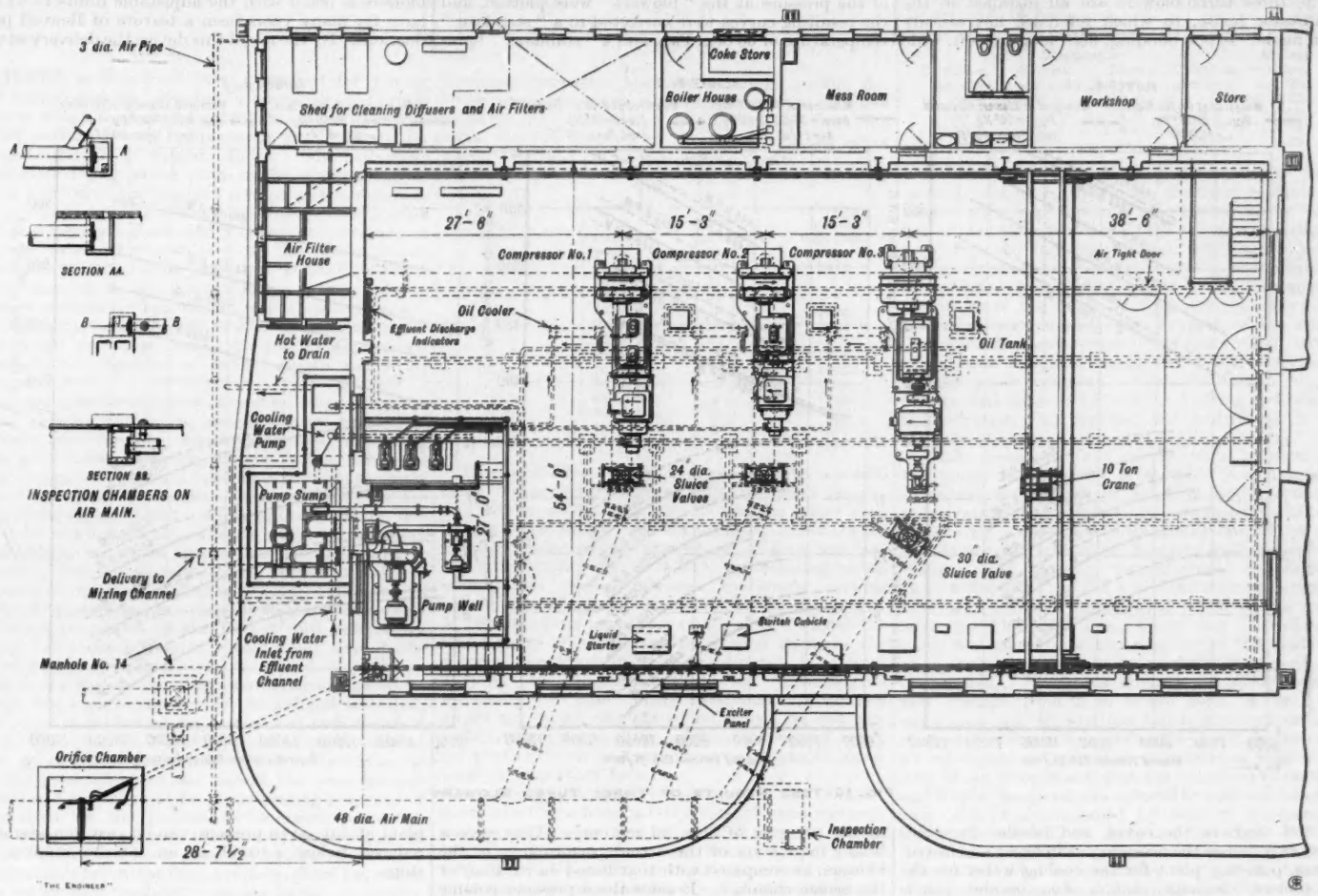


FIG. 7—ARRANGEMENT OF PLANT IN COMPRESSOR HOUSE

GEARING.

In the engraving, Fig. 6, there is reproduced a photograph of the speed-increasing gear-box for the pinion is engaged the rotation of the capstan will bring either of two gears into action. Locking arrangements prevent two gears being engaged simultaneously. On one of the smaller units—the first to be constructed—the method of selecting gears was different, each being engaged from a separate operating mechanism by the use of a single lever. A sliding wheels is provided with an operating fork and a selecting rod. The latter is cut with teeth, as a rack, with which can be engaged a pinion on the end of a shaft carrying, outside the casing, a capstan hand wheel. The selecting rods are so placed that by pulling out or pushing in the capstan the pinion can be caused to engage with one or the other. Once the

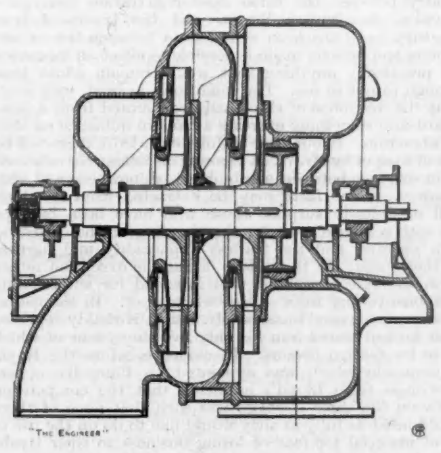


FIG. 8—SECTION THROUGH TURBO-BLOWER

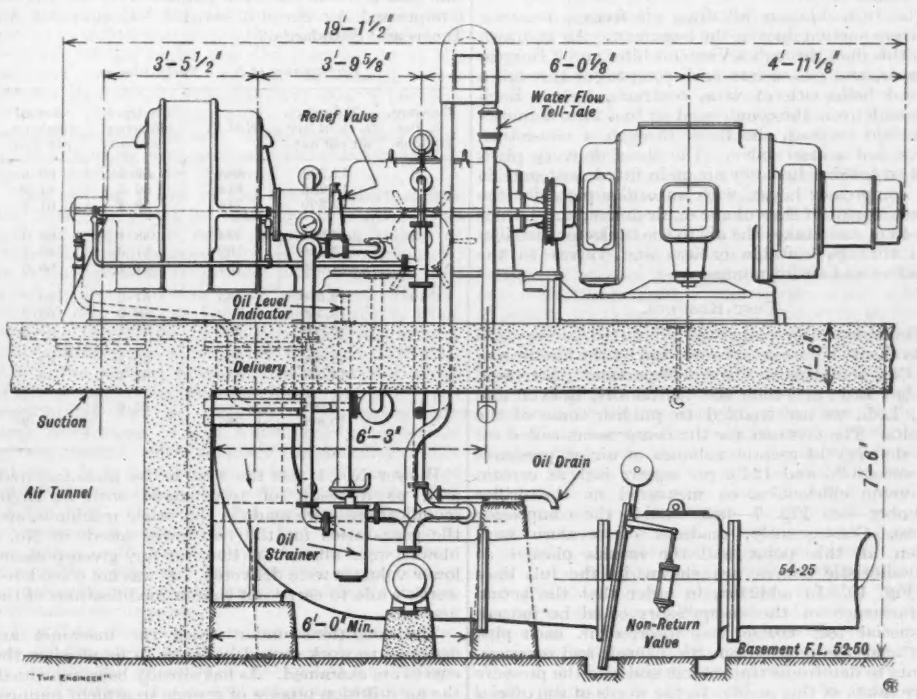


FIG. 9—ELEVATIONAL ARRANGEMENT OF TURBO-BLOWER

larger machine. It was made, like those for the smaller machines also, by David Brown and Sons (Huddersfield), Ltd. By observation of the engraving, it will be inferred that each wheel is mounted slidably on a spline shaft, while the pinion with which it engages is fixed. The centres are at 14·125in. Each pair of "Roloid" gear pump at the end of the slow-speed shaft supplies lubricant under pressure to all bearings and gears, and also to the bearings of the turbo-blower.

The larger turbo-blower is driven by an 810 h.p. Crompton Parkinson synchronous motor running at

1000 r.p.m., and the gear-box gives blower speeds of 4650, 4476, 4333, and 4182 r.p.m. The smaller blowers have 540 h.p. motors running at 1000 r.p.m., and their gear-boxes give them speeds of 5444, 5278, 5105, and 4895 r.p.m., and 5444, 5278, 5158, and 5000 r.p.m. respectively.

Arrangement of Plant.

The three turbo-blowers are all installed in the compressor house, to which reference has already been made. It is a building, 98ft. long by 60ft. wide by 22ft. high to the eaves, and besides the compressors it houses the necessary switchgear and instruments, pumping plant for the cooling water for the oil coolers, drainage pumps, &c., besides panels recording the various flows of sewage and air and the temperature and pressure of the latter, and also includes stores, workshop accommodation, a mess-room, hot water boilers, &c. Its general arrangement is shown in the plan, Fig. 7, while a photograph reproduced on page 118 gives a good idea of its internal appearance. The elevation drawing, Fig. 9, indicates how the blowers are arranged within it. Sufficient space has been left for the future installation of another blower unit larger than any of those at present installed.

The turbo-blowers all draw air from a common concrete suction duct in the basement. Air is drawn into this duct through a Visco air filter and a Burgess silencer, and passes into each compressor through a curved bellmouth of vena contracta form. Each blower delivers the compressed air to a 24in. diameter pipe laid beneath the floor, through a non-return valve and a stop valve. The three delivery pipes lead to a 48in. diameter air main fitted, just outside the compressor house, with an orifice plate for the measurement of the volume of air delivered. Thence the 48in. main takes the air to the tanks for distribution through suitable orifices and valves to the diffusers and air lift pumps.

Test Results.

The compressor plant was submitted to very full tests on site before acceptance, and by the kindness of the City of Manchester Rivers Department, Activated Sludge, Ltd., and their sub-contractors, Reavell and Co., Ltd., we are enabled to publish some of the results. The contract for the compressors called for the delivery of certain volumes of air at pressures between 8 lb. and 12 lb. per square inch at certain minimum efficiencies, as measured at the orifice chamber—see Fig. 7—just outside the compressor house. Consequently, readings of pressure were taken at this point and the results plotted as characteristic curves are shown in the full lines in Fig. 10. In addition, in order that the actual performance of the compressors could be judged, a special test nozzle was inserted in each pipe line near the outlet from the blower, and measurements to determine the volume and also the pressure were taken at this point. In the words of the official report composed by Activated Sludge, Ltd., "... this nozzle resulted in a loss of pressure ... roughly between 0·2 and 0·6 pounds per square inch. But the gauge pressure of the air was measured some distance further away, *i.e.*, at the orifice chamber, and, therefore, the units were actually discharging against a higher pressure than that indicated on the pressure gauge.... Under normal working conditions, therefore, for a given speed and gauge pressure the volume of air discharged and the horse-power used will be somewhat higher than under test conditions." In view of the reduction of pressure brought about by the presence of this nozzle, we have thought that it may be of interest to reproduce another set of curves—those shown in broken lines on Fig. 9. In order to obtain these curves, readings of the pressure at the "blowers" were plotted, and the resulting curves were corrected to a "standard" temperature of 60 deg. Fah. and a "standard" barometric pressure of 30in. of mercury. They give a better impression of the actual performance of the blowers, as compared with that based on readings at the orifice chamber. Besides these pressure-volume curves, there are plotted on the graphs curves of E.H.P. for each condition, and in an accompanying table there are given figures, extracted from the report, showing the actual and contract overall efficiency figures for the 15,000 cubic foot machine. For the purpose of obtaining these figures, the assumption was made that compression was adiabatic, and the calculations were based on measurements taken at the orifice chamber in the 48in. main for pressure and at the test orifices for volume. The formula used was that given in the book published by the British Compressed Air Society, entitled "Compressed Air Terms and Standards."

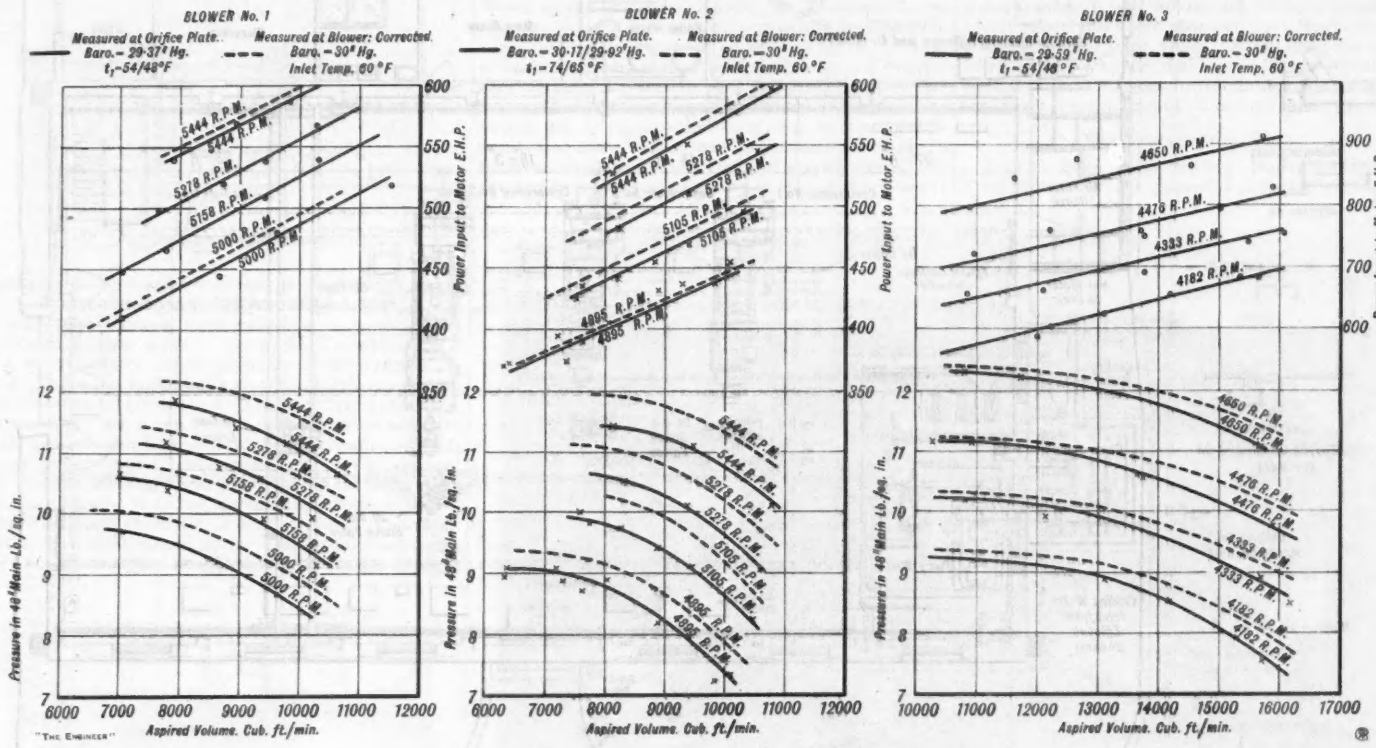

BLOWER No. 1
Measured at Orifice Plate. Baro. = 29·37" Hg. t_1 = 54/48 °F
Measured at Blower: Corrected. Baro. = 30" Hg. Inlet Temp. 60 °F
BLOWER No. 2
Measured at Orifice Plate. Baro. = 30·17/29·92" Hg. t_1 = 74/65 °F
Measured at Blower: Corrected. Baro. = 30" Hg. Inlet Temp. 60 °F
BLOWER No. 3
Measured at Orifice Plate. Baro. = 29·59" Hg. t_1 = 54/46 °F
Measured at Blower: Corrected. Baro. = 30" Hg. Inlet Temp. 60 °F
Power Input to Motor E.H.P.
Pressure in 48" Main Lb./sq. in.
Aspired Volume. Cub. ft./min.
5444 R.P.M.
5278 R.P.M.
5158 R.P.M.
5000 R.P.M.
5105 R.P.M.
4895 R.P.M.
4650 R.P.M.
4476 R.P.M.
4333 R.P.M.
4182 R.P.M.
"The Engineer"

Fig. 10—Test Results of Three Turbo-Blowers

Performance of No. 3 Turbo-Blower.

Pressure, lb. per sq. inch.	Volume, c. ft. of free air per min.	E.H.P.	Contract, efficiency, per cent.	Actual efficiency, per cent.
8	12,300	605	56·5	60·6
	13,905	644	60·5	64·3
	15,300	745	59·8	61·2
9	12,000	598	58·1	66·0
	13,410	703	61·3	62·7
	14,850	734	61·1	66·6
10	12,570	685	61·2	66·2
	13,500	770	58·3	63·2
	15,000	802	61·7	67·4
11	12,000	738	60·1	63·5
	12,555	835	61·1	58·7
12	6,000		52·0	
	10,800	797		56·9

Blower No. 1 was the first to be manufactured, and, as a result of tests made with it, slight modifications were made in the other machines, and the gear ratios for the two lower speeds of No. 2 blower were altered so that for any given pressure lower volumes were delivered. It was not considered worth while to carry out similar modifications of the first unit.

The conditions under which the machines are designed to work should be borne in mind when the curves are examined. As has already been explained, the air diffusion process of sewage treatment requires ideally that as the pressure increases the volume of air delivered should also increase. By the use of a constant-speed turbo-blower, the realisation of this ideal is impossible, but by arranging the plant in such a way that four different speeds are available, a practicable approach to the ideal is attained. For any given pressure there are at least two rates of air delivery available, so that by operating the plant for a suitable time at each speed, the average air delivery over a lengthy period can be adjusted to the required degree. Thus for a delivery pressure of 10 lb. per square inch, No. 2 blower will give a delivery of either 8800 or 10,200 cubic feet per minute at speeds of 5105 and 5278 r.p.m. respectively, while for the same condition No. 1 blower will give 7000 or 9800 cubic feet per minute. In addition, each of the turbo-blowers is fitted with the adjustable diffusers which have for many years been a feature of Reavell productions. By the use of this device the delivery of the plant at any given pressure can be very considerably reduced below normal in an infinite number of steps.

SIXTY YEARS AGO.

The unscrupulous owner who, for the sake of the insurance money, sent ill-founded, worn-out ships to sea on voyages from which they were not intended to return is a figure not only of fiction but of actual fact. That he ever could have existed obviously implies the prevalence in the marine insurance market of conditions greatly different from those of to-day. If he is no longer with us it is not because of the growth of a higher morality but because of the virtual impossibility in these days of effecting the insurance of an unseaworthy ship and of clearing her for sea. Sixty years ago while Plimsoll and his friends were struggling in Parliament to secure much-needed reform in the Merchant Shipping Acts the intense rivalry between the three chief registration societies—Lloyd's, the Bureau Veritas and the Liverpool Iron Registry—and the keen competition between the underwriters and brokers made it possible to effect an insurance on practically anything that would remain afloat long enough to put to sea. The conditions, in brief, were such that the insurance of ships had degenerated from a safeguard into something exerting a baneful influence on ship construction. In our issue of July 30th, 1875, there will be found a paper by Mr. W. M. Fenning discussing the relations then existing between shipbuilders, shipowners and ship insurers. Some facts may be extracted from it which will doubtlessly surprise those who have been brought up with a high respect for the standing of the classification societies and the fearless impartiality and fairness of their rules. In those days it was the exception rather than the rule to submit iron intended for shipbuilding purposes to any form of test whatsoever. In the course of over nine years' business Mr. David Kirkaldy reported that he had tested iron for only five ships, four of which were for foreign owners. In evidence before the Royal Commission which was appointed on Plimsoll's appeal a witness from Lloyd's admitted that the competition between the three societies was such that none of them could insist as fully as they would like to do on the use of good material for fear of losing business to their rivals. Lloyd's, he said, did not impose any tests and on its books and those of the other societies there were many ships which were made of bad iron and some of very bad iron. The registration books, Mr. Fenning said, were thoroughly unsatisfactory. Competition between the societies had led them to subordinate consideration for the safety of life and property to the determination to maintain their incomes. Outside the societies, competition among the underwriters, insurance brokers and average adjusters was acting less directly but not less effectively to encourage unseaworthiness in vessels while the law itself by reason of certain established fictions smoothed the path of those to whose benefit it was to exploit it. The key to the improvement of the prevailing conditions lay in Mr. Fenning's opinion not so much in legislative action as in combination among the underwriters and the amalgamation of the classification societies.

Production and Application of Silver Solders.

By EDMUND R. THEWS.

No. I.

SILVER solders have been employed for joining bronze and steel articles for many years. Certain stable alloys were used for bronzes, others for steel, while certain special compositions were reserved for nickel-silver and similar alloys. The advances achieved during recent years in the development of heat and corrosion-resistant ferrous and non-ferrous alloys have naturally raised the question of joining on to a different plane, and it is impossible to-day to obtain satisfactory results with the rule-of-thumb methods practised some years ago. It has been found advantageous in the case of many new alloys to attain maximum chemical and mechanical properties of joints by means of autogenous or electrical welding which ensures a much more perfect approximation of the properties of welded metals and welds proper.

In many other instances, however, where for practical reasons welding is undesirable or impossible, solders must be used, which, without deteriorating the mechanical properties of the joints, exhibit a high degree of corrosion resistance towards as many corrosive agents as possible. Solders of this type are the silver solders which are exceptionally strong and ductile, besides offering a wide range of corrosion resistances, and since these solders in their binary, ternary, and quaternary forms permit of almost unlimited variation of their mechanical and chemical properties, they can be adapted to the innumerable different properties of the ferrous and non-ferrous alloys to a much greater extent than any of the other groups of solders.

It is for this reason that this important group of alloys has found considerable professional attention, not only in perfecting its mechanical and chemical properties, but in developing its electro-chemical and its electrical properties as well. The influence of the presence of special metals has been investigated and the range of the deteriorating influence of impurities on the various technological properties has been determined. Since the application of these solders had been considered more or less of a tradesman's art rather than a science, there have been few earlier investigations or studies to fall back upon, but it has been possible during recent years to accumulate sufficient facts to render the silver solder alloys the most important group of industrial hard solders.

The applicability of the silver solders to the various metals and alloys (copper, brasses, nickel brasses, bronzes, steels) is determined by the following factors:—

(1) Proportions of the chief constituents within the alloys.
(2) Percentages of special constituents present.
(3) Kind and quantity of impurities.
(4) Methods of manufacture.
(5) Soldering processes applied (temperatures, fluxes, finishing treatments, &c.).

(1) The choice of the proportional relations between the three chief constituents of the silver solders, copper, silver, and zinc, is naturally determined by the mechanical, chemical, electro-chemical, and physical properties of the metals to be joined. It does not suffice under modern conditions merely to approximate to conditions, since in many instances a slight variance of electro-chemical potentials, &c., might cause serious corrosions of the joints, and, finally, the destruction of the soldered parts, so that it will undoubtledy prove more economical to pay more attention to the choice of the alloys employed.

This choice is often rendered more difficult by other considerations, such as melting temperatures, &c. For instance, it is a peculiar fact that the brazing temperatures of most of the solders suitable for austenitic, acid-resistant steels are located within a temperature range which is particularly unsuitable for the structural properties of these alloys. It is possible in this particular instance to select the alloying proportions so as to raise the correct brazing temperatures above the critical range of these steels, *i.e.*, to about 1550–1600 deg. Fah. This temperature is rather high for the alloys concerned, but it can still be attained with the aid of suitable fluxes and by using the necessary precautions. Conditions are rather more complicated if the critical temperature range of a certain alloy extends too far beyond the proper brazing temperatures, and it is necessary then to employ silver solders having brazing temperatures below the critical range and exhibiting technological properties as nearly resembling those of the soldered material as possible. These are the limiting conditions for silver solders, and since other soldering metals will hardly prove to be more suitable under these conditions, it remains only to join these metals by welding.

Most of the silver solders employed for industrial purposes are ternary alloys, containing one or more special constituents such as cadmium, nickel, &c. There are some binary silver-copper alloys and a few ternary silver-cadmium-zinc alloys. The following table gives a number of the more common silver solder mixtures with their melting points:—

TABLE I.

Composition. Copper, per cent.	Silver, per cent.	Zinc, per cent.	Melting point, deg. Fah.
52·5	25·0	22·5	—
51·0	9·0	40·0	1570
38·0	30·0	32·0	—
36·0	40·0	24·0	—
34·0	50·0	16·0	1425
32·0	50·0	17·5	1425
30·0	45·0	25·0	1375
25·0	60·0	15·0	1350
25·0	70·0	5·0	1430
22·0	75·0	3·0	1430
20·0	65·0	15·0	1325
20·0	70·0	10·0	1400
20·0	75·0	5·0	1430
16·0	80·0	4·0	1460

It is useful for a number of purposes to separate these ternary silver solders into two main groups, *i.e.*, into a silver-rich group, containing more than 50 per cent. silver and representing silver-copper alloys containing lesser percentages of zinc, and into the silver-poor group of alloys, representing to all intents and purposes brasses containing varying percentages of silver. It will be found that many of the divergent properties of the alloys within the main group of alloys can be traced back to the differing characters of these sub-groups. It is quite obvious, for instance, that the technological properties of the first sub-group (silver-rich alloys) are to a great extent influenced by the proportion of copper to silver, while in the second group the relation between zinc and copper contents represents an important factor.

A very important field of usefulness of the "brass" group of silver solders is the joining of brass sections, such as tubes, wire, &c., before or during the manufacturing process, where the brazed joint is thus subjected to the rolling or drawing stresses together with the soldered material. Best results have been obtained with the solder containing from 40 to 50 per cent. silver, and with a copper-zinc ratio of 3 : 2. A typical mixture of this type contains 40 per cent. of silver, 36 per cent. of copper, and 24 per cent. of zinc, while the solder with the most satisfactory mechanical and chemical properties after mechanical working (rolling, drawing, &c.) contains 45 per cent. of silver, 33 per cent. of copper, and 22 per cent. of zinc.

The tensile strength of all these solders, equalling those of the soldered parts in any case, is usually still further increased by diffusion phenomena. The extent of diffusion is chiefly determined by the silver contents of the solder and the composition of the soldered parts. For instance, in brazing brass articles, with alloys containing from 45 to 50 per cent. of silver, the tensile strength of the brazed joints exceeds considerably that of the solder alloy itself, while in brazing steel parts and nickel-rich materials reverse conditions are obtained.

The melting points of the ternary silver solders are chiefly governed by their zinc contents. With uniform copper-zinc ratios the melting points of these alloys are decreased by rising silver contents. It is thus possible to produce solders of this type which exhibit a melting point as low as 1345 deg. to 1375 deg. Fah. at 70 per cent. of silver, while replacing 10 per cent. of this silver with zinc reduces this melting point still further to about 1325 deg. Fah. The melting points of the silver-poor alloys of this group, on the other hand, can only be lowered considerably by the addition of correspondingly large percentages of zinc which, beyond a certain critical amount, tends to lower the ductility of the solders. It is possible for certain medium type of articles to employ solders containing about 25 to 30 per cent. of silver, and approximately equal percentages of copper and zinc, but it is advisable to use alloys with higher silver contents and more favourable copper-zinc ratios for high-grade brazing purposes where maximum strength and high corrosion resistances are required.

It will be necessary before discussing the application of the silver solders to the various purposes to describe the influence of the special constituents and impurities on the technological properties of the solders, and to review the methods of manufacture as far as these influence their application.

(2) and (3) The special constituent most commonly added to the ternary silver solders is cadmium, which, under certain circumstances—that is to say, where particularly low melting and soldering temperatures are required—may replace the whole of the copper. However, where cadmium is added to these solders in smaller amounts, it does not lower the melting points of the alloys—as is frequently supposed—its general tendency being towards the other direction. The only exceptions to this rule are formed by the alloys low in silver, while the melting and brazing temperatures of the silver-rich alloys are generally raised by cadmium additions. Table II shows this influence of cadmium in an alloy originally composed of 65 per cent. of silver, 20 per cent. of copper, and 15 per cent. of zinc.

TABLE II.

Composition. Silver, per cent.	Copper, per cent.	Zinc, per cent.	Cadmium, per cent.	Melting point. deg. Fah.
65·0	20·0	15·0	—	1325
65·0	20·0	10·0	5·0	1350
65·0	20·0	5·0	10·0	1370
65·0	20·0	—	15·0	1385

Different conditions and temperature ratios prevail, of course, where the cadmium replaces the copper or silver, but this alternative is not satisfactory for other reasons. If the addition of cadmium is to improve the ductility and working properties of the silver solders, it must be added at the expense of the zinc. If it is employed to displace the copper, it will lower the melting and brazing temperatures as well as the ductility and strength of the seams. The maximum percentages of cadmium which may be added to obtain best results are chiefly determined by the silver contents. Excess cadmium beyond this critical range will lower the melting and brazing temperatures, but increase the brittleness of the alloys at the same time.

While there can thus be no doubt in regard to the beneficial influence of suitable percentages of cadmium, tin appears to be an undesirable constituent rather than a useful one, although it has been praised by quite a few older authorities. It is true that larger additions of tin to silver solders lower the melting and flowing temperatures considerably (4 to 6 per cent. tin will lower the melting temperature of a medium solder with 57 to 60 per cent. silver to 1150–1200 deg. Fah.), but it will also lower the ductility of the alloy, or of the soldering seam, to a point where its workability is seriously endangered. Numerous commercial silver solders still contain from 2 to 5 per cent. of tin; but experience has shown that the relative advantages of some of these solders are certainly not due to their tin contents, and practical tests with a number of such alloys have shown that the reduction of melting and flowing temperatures induced by such tin contents were always accompanied by relative increases of brittleness as well as, in some instances, lowered corrosion resistance. In any case, it is difficult to understand why as expensive and as doubtful a metal as tin should be added instead of the relatively cheap zinc whose beneficial influence on the soldering properties of these alloys has been proved beyond doubt.

Nickel addition increases the strength and hardness of silver solders without at the same time increasing the brittleness. This constituent is also beneficial in that 1·5 to 2 per cent. of nickel improves the corrosion resistance of the brazed joints considerably and reduces the corrosion tendencies due to electro-chemical difference between the solder and the brazed articles. This influence, which has not been sufficiently explained scientifically as yet, is similar to that exerted by corresponding quantities of nickel on zinc-rich brass alloys (60/40). A slight disadvantage of nickel additions is the fact that even smaller quantities of this metal tend to raise the melting and flowing temperatures, but this increase is not very pronounced, and it is possible with an addition of 2 per cent. nickel to attain melting points of less than 1460 deg. Fah. with most of the alloys enumerated in Table I.

Iron and lead are the most undesirable common constituents of silver solders. They increase strength and hardness in a similar manner to nickel, but the brittleness is also increased proportionally. These two constituents tend to deteriorate silver solders if present in tiniest quantities, and even traces of these metals must therefore be avoided. It is for this reason that iron tools for mixing and dressing fused silver solder are not considered good practice. Where graphite rods are not obtainable and iron or steel tools form a necessary adjunct, they should be lined with basic fire-clay paste carefully dried before dipping them into the metal. Nickel-copper alloy rods or straight copper tools have also been recommended for this purpose, and the latter may be employed without hesitation if they are not left in the bath until red hot, although a slight amount of corrosion does not hurt the melt, of course.

It is obvious from the above that while cadmium and nickel may be considered valuable special constituents of silver solders, iron and lead are straight impurities. The properties conferred by tin are by no means satisfactory, but since for some reason or other it is often added intentionally, and since very small quantities of this metal (*i.e.*, the usual percentages of straight impurities), exert definite changes, it should also be grouped with the special constituents.

(4) In view of the deteriorating properties of the two chief impurities, iron and lead, which form common constituents or impurities of many industrial copper alloys, it is necessary to employ only pure metals in the production of silver solders. Where copper, silver, and zinc are melted together, only the best refined, purest grades should be considered,

best results being obtained with best electrolytic qualities. The higher the silver contents of the solders the less pronounced is the influence of lead, iron, and the minor impurities on the technological properties of these metals; but many of the common grades of virgin copper and zinc contain sufficient impurities to affect the properties of even the silver-rich solders noticeably.

It is a matter of fact that really homogeneous alloys are with difficulty obtained if the three metals are melted together. It is for this reason that manufacturers frequently remelt the alloy once or twice, casting the metal into ingots the first time. While this process tends to improve homogeneity, it is disadvantageous in raising the amount of impurities contained, besides increasing the prime cost of the products. Almost perfect homogeneity of silver solders can, however, be obtained by alloying the silver with the requisite amounts of brass, the brass usually being added to the fused silver in form of clippings or chips. While the principle of this process is sound, the use of chips and similar mechanically worked brass material is inadvisable, since, in view of the exceedingly large increase of surface area of the brass the amount of oxide and other impurities introduced into the bath become quite noticeable. It is also important not to use any kind of brass which happens to be available. The brass employed for this purpose must be especially compounded so as to contain all the copper and zinc required for the final alloy. It should be cast into small-block ingots which are then broken and charged into the fused and slightly superheated silver.

Before adding the brass the surface of the silver bath must be covered with a flux layer consisting of equal parts of borax and boric acid, which should also be employed in the production of the preliminary brass alloy.

After adding the brass to the silver, the fused mixture is gradually superheated by about 125 deg. Fah. It is then stirred thoroughly, cooled down by about 75 deg. Fah., stirred again, deoxidised, and poured into suitable steel moulds. Deoxidation is best effected by adding 0·5 per cent. of phosphor copper (containing 15 per cent. of phosphorus). A small excess of phosphorus in the solder, not exceeding about 0·05 per cent., does not harm the product. Indeed, many soldering alloys of this type contain small percentages of phosphorus intentionally added for its beneficial influence during the brazing process. It appears that the phosphorus generates small quantities of vapours during the melting of the solder, which surround the melt with a dense layer of reducing gas, preventing the oxidation of the metal. Part of the phosphorus remaining within the melt deoxidises the soldering metal proper, so that the general effects are quite favourable. Some silver solders contain manganese and silicon for the same purposes, but their influence on the oxidising resistance, and their general influence on the technological properties of silver solders, have not been sufficiently investigated as yet.

(To be continued.)

Developments in Cross-Channel Packets.

By G. W. TRIPP, F.C.G.I., M. Inst. C.E., M.I. Mech. E.

IT is now many years since there has been published a review of the developments in the cross-channel packet, a class of craft which is in many ways of particular interest. Descriptions of different vessels have appeared from time to time in these pages, but they in themselves hardly enable the reader to take stock of the situation as a whole, or to realise the strides that have been made in the evolution of a vessel which is to be found in large numbers on the various passages across those narrow waters which separate Great Britain from her neighbours.

For many years the paddle steamer was regarded as ideal for cross-channel work, not only on account of its shallow draught, a valuable asset in some of the early Continental harbours, but also on account of the rapidity with which it could be brought to rest, while at the same time passengers had more faith in its steadiness in a seaway. In spite of the considerably increased speed of modern steamers, it is probable that in the case of some of the shorter passages the pier-to-pier records of paddle veterans have not been beaten.

It may surprise many to learn that a quarter of a century ago quite a large number of this class of vessel was actively employed, and in my records of that period I find the names of some twenty-seven paddle steamers plying on the principal routes. Of these, ten were available for the Dover-Ostend passage, and six flew the house flag of the Isle of Man Steam Packet Company. The day services of the Zeeland Steamship Company between Flushing and Queenborough were being maintained by large paddle boats, yet on the short Dover-Calais passage only two British steamers of the old type were at work, although the number was doubled by the two celebrated French mail boats "Le Nord" and "Le Pas de Calais." These had the distinction of being the last paddle steamers definitely employed on cross-channel duties.

Although for the longer passages to the Channel Islands and on the Continental services of the London and South-Western Railway, as well as across the Irish Sea, the screw steamer had firmly established herself, a few survivors lingered, and "Norah Creina," built in 1878, and "Iverna" of 1895, were still on the active list of the Lancashire and Yorkshire Railway for sailing between Liverpool and Drogheda, and "Paris" (1888) was still available at Newhaven. Apart from these notable exceptions the old type had vanished from all but the shorter passages, if the Isle of Man sailings are classed among the short ones.

There was a similarity in design and general appearance between the remaining large paddle boats, so that the fine "Empress Queen," sailing to Douglas, had much in common with "Marie Henriette" on the Ostend route or "Koningin Regentes" plying between Queenborough and Flushing. "Le Nord" and her sister, the last paddle cross-channel steamers to be built, had but one funnel, but the difference was more apparent than real. These two steamers were among the fastest of their class, maintaining, as they did, a speed of 21·5 knots at a horse-power of 8000. They were driven by triple-expansion engines and steam was raised in La Graffel and d'Allast water-tube boilers, the heating surface being 16,146 square feet, and the grate area 516 square feet. The working pressure was 186 lb. per square inch. Bow rudders were provided.

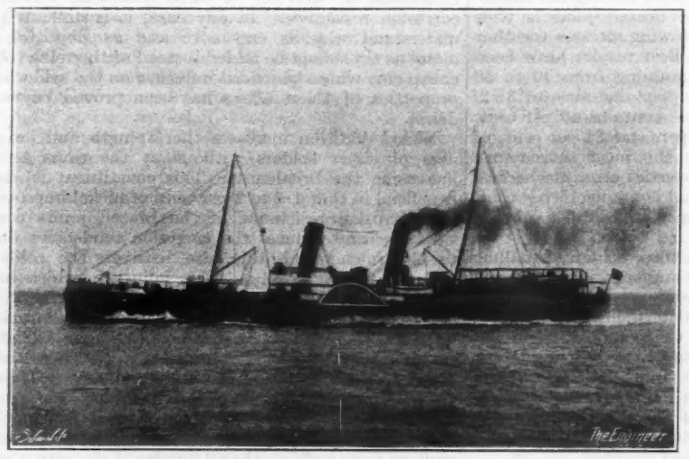
In all these paddle steamers the saloon accommodation was situated at the stern, and the shelter deck was very limited, so that in inclement weather the choice usually lay between exposure on deck or a retreat to the saloon.

The leading dimensions of some of the vessels built during the last decade of the paddle steamer will be found in Table I.

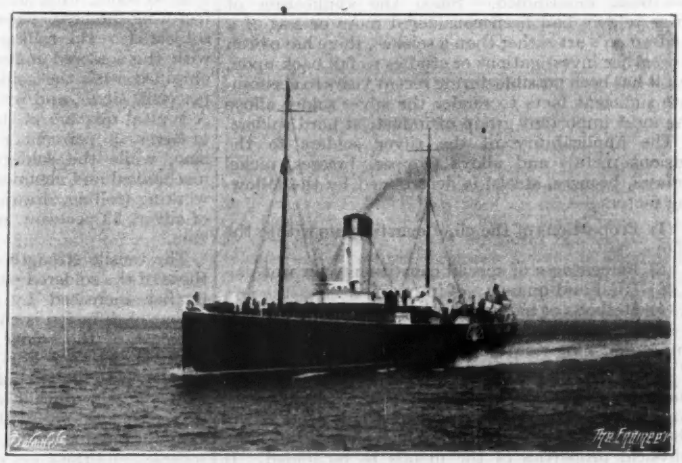
Two factors hastened the end of the cross-channel paddle steamer: first, the Great War, when they rendered yeoman service as mine sweepers and transports, some being lost, and others so severely used that it was not considered worth while to recondition them; and, secondly, the advent of the marine steam turbine early in the twentieth century. The high speed of the engine necessitated smaller propellers, which were not very efficient, but gave the advantage of tending to remove some of the difficulties of screw propulsion for shallow-draught steamers.

It must be placed to the credit of the old South-Eastern and Chatham Railway that it was the first to introduce a cross-channel turbine steamer, "The Queen," in 1903, only a year or so after the principle had first been applied to a passenger steamer on the Clyde, and that to a steamer which was only called upon to sail under propitious summer conditions. Now that the turbine steamer has so thoroughly established herself it is hard to realise the boldness of the railway in turning from the popular paddle steamer, for had the experiment failed there would have been many complaints of rashness and the usual cheap gibes at this particular railway.

"The Queen" was propelled by three separate turbines, each driving its own shaft, the centre one being high-pressure and the two side ones low-pressure. On the centre shaft was a three-bladed propeller of 3ft. 6in. diameter, while the two side shafts had similar propellers, but of 2ft. 3in. diameter. The speeds were different, the centre shaft running at 700 and the side ones at 500 r.p.m. In manœuvring the centre turbine was cut out, so that the ship virtually became twin-screw, the unused turbine merely revolving idly *in vacuo*. Inside the exhaust end of the low-pressure turbines was placed an astern turbine, controlled by slide valves operated by combined steam and hydraulic reversing engines.



ZEELAND STEAMSHIP COMPANY'S "ENGELAND"—1895



NORD COMPANY'S "PAS DE CALAIS"—1898

TABLE I.—*Some of the Paddle Steamers Built in the Last Decade of the Nineteenth Century.*

Steamer.	Owner.	Builder.	Date built.	Leading dimensions (in feet).			Gross tonnage.	Engines.
				Length.	Breadth.	Depth.		
"Marie Henriette" ..	Belgian Government ..	Société Cockerill	1893	340·0	38·0	15·0	1451	Two cylinders, 60in., 108in. diameter, 84in. stroke
"Koningin Regentes"	Zeeland S.S. Co.	Fairfield Shipbuilding	1895	320·0	35·8	16·0	1970	Three cylinders, 51in., 75in., and 112in. diameter, 78in. stroke
"Calais"	S.E. and C.R.	W. Denny and Bros. ..	1896	280·0	35·0	13·4	1002	Three cylinders, 35½in., 52½in., and 76in. diameter, 72in. stroke
"Empress Queen" ..	Isle of Man S. Packet Co.	Fairfield Shipbuilding Co.	1897	360·1	42·3	17·0	2140	Three cylinders, 68in., 92in., and 92in. diameter, 84in. stroke
"Le Nord"	Chemin de Fer du Nord ..	Société des Chantiers ..	1898	337·8	34·9	14·2	1541	Three cylinders, 41in., 59in., and 87in. diameter, 89in. stroke

Steam was supplied by two double and two single-ended Scotch cylindrical boilers built by Denny and Brothers and working at a pressure of 150 lb. per square inch. The centrifugal circulating pumps and air pumps were driven by independent double-cylinder steam engines, and the feed water was supplied by two Weir pumps.

During the official trials a mean speed of 21·76 knots was obtained on two runs, but still more

interesting was the fact that it was found possible to reverse from a forward speed of 20 knots and bring the vessel to rest in two and a-half times her own length in one minute seven seconds.

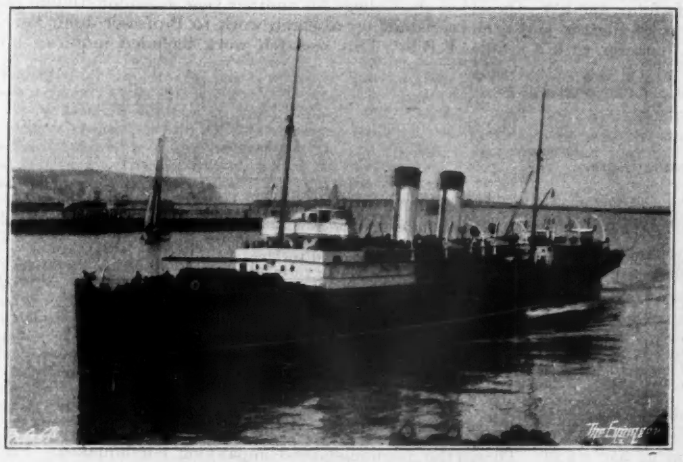
Thus a definite increase in speed over the paddle boats was obtained, and freedom from engine vibration was very noticeable, but it must be confessed that propeller vibration was by no means absent.

So satisfied was the company with her performance that no more paddle steamers were built, and by degrees a fleet of triple-screw turbine steamers came into being. As other companies followed suit, for many years this type became the standard, and although the twin-screw reciprocating engined vessel maintained a place, it never gained the ascendancy of either the paddle or turbine steamer.

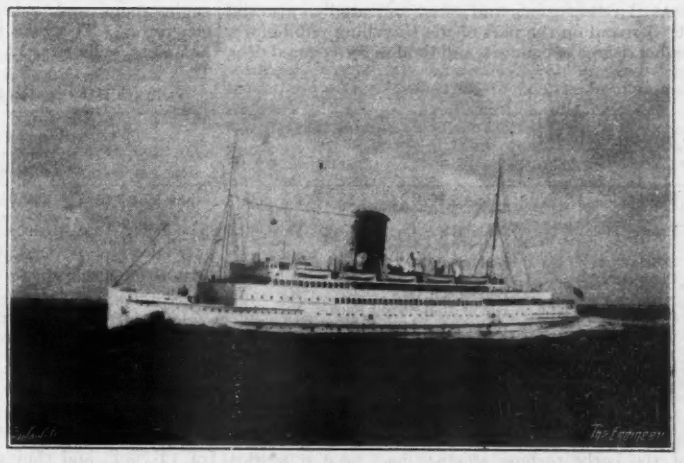
The Midland Railway carried out some very valuable trials to determine the relative efficiency of the turbine and reciprocating engine for marine propulsion, by having boats built and tried out on the Heysham-Belfast service. These steamers were similar in general dimensions, but one was driven by turbines, the other by reciprocating engines. Although by no means a "walk-over" for the turbine, these trials undoubtedly contributed to the favour in which it was being held. It is perhaps worth mentioning that "Antrim," the twin-screw steamer, is still actively employed, though disguised under the name of "Ramsey Town," and flying the flag of the Isle of Man Steam Packet Company.

With the disappearance of the paddle steamer a definite change took place in saloon arrangement, and the first-class was transferred from stern to bow and amidships. The fact that this was now much the steadiest part of the vessel had probably a good deal to do with the change.

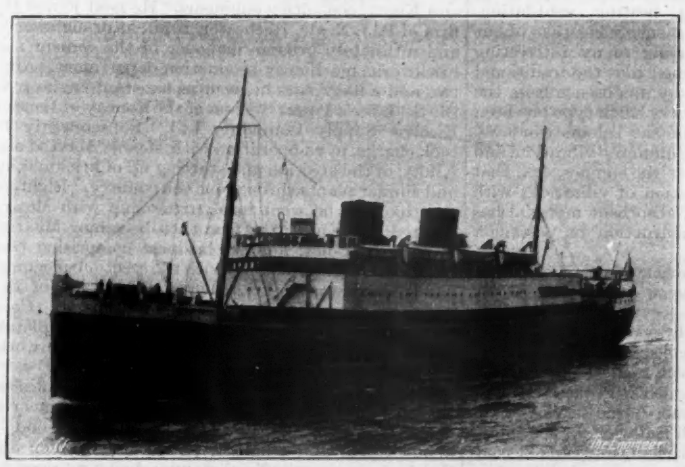
Dimensions of some of the interesting steamers that were built immediately after the *régimé* of the paddle steamer will be found in Table II.



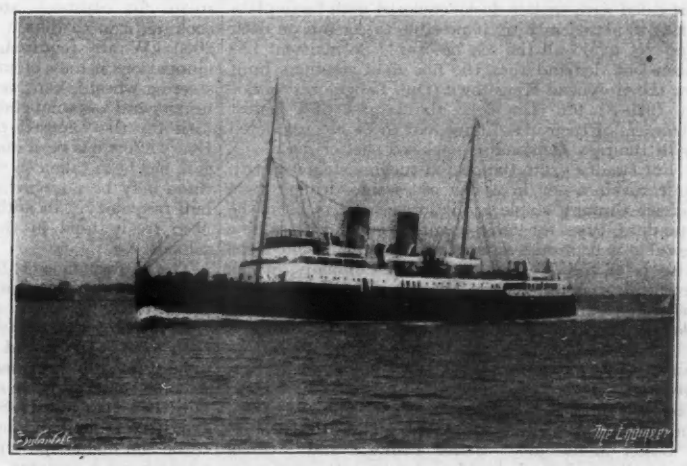
S.E. AND C.R. TURBINE STEAMER "THE QUEEN"—1903



ISLE OF MAN S.P. COMPANY'S "BEN-MY-CHREE"—1927



BELFAST S.S. COMPANY'S "ULSTER PRINCE"—1929



SOUTHERN RAILWAY "ISLE OF JERSEY"—1930

but propeller efficiency was much increased and cavitation losses minimised.

Contemporaneously with these changes in the engine-room, other, if less noticeable, developments were taking place in the stokehold, and oil fuel was taking the place of coal to a considerable extent. At one time it appeared as if high-pressure boilers were likely to find favour, but apparently the experiment on the Clyde, with the turbine steamer "King George V," which had water-tube boilers working at a pressure of 550 lb. per square inch, was not considered sufficiently encouraging to warrant application to cross-channel packets.

Among the most interesting steamers of this class is "Canterbury," built to meet the most exacting requirements, and although certified for 1700 passengers, the original intention was to carry only about 300, all first class, in connection with the "Golden Arrow" services. She has twin screws driven by two sets of Parsons turbines through single reduction gears. There is one high-pressure and one low-pressure turbine, each driving through flexible couplings its respective pinion, which is geared to the propeller shaft by a common gear wheel, helical teeth being used. In the high-pressure turbine an impulse wheel carries two rows of blades, the rest of the blading being of the reaction type. In the after end of both H.P. and L.P. turbine casings the astern turbines are fitted. Each set exhausts to a two-flow condenser of Weir regenerative type working with Weir air pump and Paul circulating pump. A vacuum of 28¾in. is maintained.

Steam is raised in four water-tube Babcock and Wilcox boilers working at a pressure of 225 lb. per square inch, and the boilers are arranged for oil fuel on the closed stokehold system under air pressure, the air being supplied by two large fans of Paul's make. The oil burners are fed by the Babcock and Wilcox high-pressure method.

There are commodious and well-arranged shelter decks, and glass surrounded verandahs with comfortable armchairs, also a large number of private *de luxe* cabins, and spacious well-ventilated saloons. Such is the high standard demanded nowadays in a packet engaged on a short day passage.

For night work conditions are different and speed is not so essential, but a considerable amount of space is necessary for state rooms, &c. Among the largest geared turbine steamers on night duty are the three Hook of Holland mail steamers of the London and North-Eastern Railway, "Amsterdam," "Prague," and "Vienna," which, with their 4200 tons, would have been regarded almost as liners a few years ago. These steamers attain the creditable speed of 21½ knots, and in general arrangement of engines are very similar to "Canterbury," but in this case they are driven by Brown Curtis compound turbines.

Another class of vessel is that which is called upon to perform night duty in one direction, but a regular day passage on the return, thereby having to provide two types of passenger accommodation, but the problem has been satisfactorily solved in the Southern

TABLE II.—*Typical Steamers in the First Decade of the Twentieth Century.*

Steamer.	Owner.	Builder.	Date built.	Leading dimensions (in feet).			Gross tonnage.	Engines.
				Length.	Breadth.	Depth.		
"Anglia"	L. and N.W.R.	W. Denny and Bros.	1900	329·0	39·1	15·7	1862	Eight cylinders (twin screw) 26in., 40in., 43in., 43in. diameter, 33in. st.
"The Queen"	S.E. and C.R.	W. Denny and Bros.	1903	309·9	40·0	15·7	1676	Triple screw, three turbines
"Antrim"	M.R.	J. Brown and Co.	1904	330·9	42·2	17·2	2100	Eight cylinders (twin screw), 23in., 36in., 42in., 42in. diameter, 30in. st.
"Londonderry"	M.R.	W. Denny and Bros.	1904	330·6	42·1	17·1	2086	Triple screw, three turbines
"Viking"	Isle of Man Steam Packet Co.	Armstrong, Whitworth and Co.	1905	350·4	42·0	16·1	1951	Triple screw, three turbines
"St. Andrew"	Fishguard and Rosslare Railways and Harbours	J. Brown and Co.	1908	351·1	41·1	16·5	2528	Triple screw, three turbines

It was with a view to eliminating, or at least materially reducing, propeller vibration that experiments were made in introducing gearing, and probably

Railway's "Isle of Jersey," "Isle of Guernsey," and "Isle of Sark," on the Channel Islands services. Again, the propulsion methods are similar to those

already described, and the turbines are of Parsons type, and the propellers run at 250 r.p.m. In the case of these steamers steam is raised in three Scotch boilers of the single-ended return type, and they are oil fired, the boiler pressure being 200 lb. per square inch. There are spacious oil tanks on both sides of the stokehold. The oil-burning installation was supplied by White's Patent Oil Burning Company, of Hebburn-on-Tyne.

A notable innovation was made in "Isle of Sark," in that her hull is of a modified Maier-form type, the Southern Railway not being prepared initially to accept the full extent of "cut up" forward necessary for it to be of complete Maier-form. The special curve of the bow is so arranged as to reduce the resistance of the ship in calm weather, and to enable a higher speed to be maintained in heavy seas. This is the only example of this construction in this country as far as this class of steamer is concerned. Incidentally it might be mentioned that the speed of these Channel Islands boats is about 19½ knots.

As the dimensions and speed increased so also did the demand on the part of the travelling public for a higher degree of comfort, and though the covered deck said to have definitely broken away from many stereotyped conventions, and the Société Anonyme John Cockerill is to be complimented on this very original product of its yard. The casual observer is impressed by her strange appearance, for there is not the slightest rake to her short mast and funnel, the latter being stumpy and broad and sometimes quite lost to view. Her lines, too, are original, and large plate glass windows are much in evidence, these affording an unobstructed view from the dining saloons, in which, incidentally, 300 meals can be served simultaneously.

She is driven by two-stroke single-acting Sulzer-Cockerill c.i. oil engines, each of which has twelve cylinders of 22·8in. diameter and 33·1in. stroke. At 250 r.p.m. the engines develop 7500 b.h.p. and at 268 r.p.m. 8500 b.h.p. During her trials she attained an average speed of 25·25 knots, developing 16,000 b.h.p., the thrust being 72·5 tons. This speed constitutes a definite record for a vessel of this type.

The auxiliary engines are situated in a separate engine-room and consist of four 480-kW Diesel generators. They are four-stroke engines and each has eight cylinders, 12·21in. diameter with a stroke speed, or from the very important standpoint, that of the passenger using them for but a brief few hours at a time.

Obituary.

W. J. COLES.

We greatly regret to have to record the death, on July 25th, of Mr. Walter James Coles, a director of Edgar Allen and Co., Ltd., and manager of the engineering department of that firm.

Mr. Coles was born on November 1st, 1874, at Cranbrook, Kent. On leaving school he went to Hull, where he spent a few months in the shops of an engineering works. Thence he went to the City and Guilds Engineering College, Finsbury, as a student, for three years. After obtaining the College certificate in mechanical and electrical engineering, he remained at the College for another year as senior student and assistant on research work to Professor John Perry, F.R.S. This research work included inquiries into the phenomena accompanying earthquakes. From Finsbury he returned to Hull, where for six months he was employed as an assistant by Messrs. Maxted and Knott, consulting engineers. He next joined the firm of P. J. Neale, Rochester, Kent, as draughtsman, and ultimately became manager of the cement and brickworks machinery production department. After two and a-half years he went as assistant engineer to the St. Luke's Power Station of the County of London Electric Supply Company, Ltd. Subsequently he took charge, in co-operation with Messrs. Maxted and Knott, of the erection and starting up of brickmaking and similar plants throughout the country. Eighteen months later he went into partnership with Messrs. Maxted and Knott, the firm then becoming Maxted, Knott and Coles, and its business comprising consulting work in connection with the erection of cement works, brickworks, &c. During the period of this partnership, which lasted eight years, Mr. Coles electrified the first cement works to be completely driven by electric power in this country—the works of Casebourne and Co., Ltd., Haverton Hill.

When the partnership came to an end Mr. Coles set up in practice in London as a consulting engineer in connection with cement plant, &c. At the end of about a year and a-half he joined Edgar Allen and Co., Ltd., in a semi-official manner, being retained by the firm as a technical consultant on cement plants, but continuing to live in London, and preserving a considerable measure of independence. Eventually his connection with the firm became closer, and he was invited to go to Sheffield for the purpose of taking over the management of the engineering department. He agreed and went to Tinsley early in 1914. In 1923, as a result of his work for the engineering department, he was elected to the board of directors. The engineering department, when he took charge of it, had not been quite as successful as some of the others for several years. At the end of eighteen months, after his arrival, it made a small profit. Thenceforward it has been one of the firm's most important departments and its turnover has grown very greatly.

Mr. Coles was a member of the Institution of Electrical Engineers, chairman of the Rexman Mill Company, London, and director of Stein and Atkinson, engineers, of London.

Table III.—*Typical Examples of Vessels Now at Work.*

Steamer (or motor vessel).	Owner.	Builder.	Date built.	Leading dimensions (in feet).			Gross tonnage.	Engines.
				Length.	Breadth.	Depth.		
"Normannia"	L. and S.W.R.	Fairfield Shipbuilding Co.	1911	290·3	36·1	15·3	1567	Twin screw, two geared turbines
"Prinses Juliana"	Zeeland S.S. Co.	Fairfield Shipbuilding Co.	1920	350·4	42·7	23·9	2908	Eight cylinders (twin screw), 28in., 43½in., 49in., 49in. diameter, 33in. stroke
"Scotia"	L.M. and S.R.	W. Denny and Bros.	1921	380·5	45·2	26·2	3454	Twin screw, four geared turbines
"Canterbury"	S.R.	W. Denny and Bros.	1929	329·6	47·1	16·9	2910	Twin screw, four geared turbines
"Ulster Prince"	Belfast S.S. Co.	Harland and Wolff	1929	346·0	46·2	15·2	3757	Twin screw, oil engines, twenty cylinders
"Lady of Mann"	Isle of Man Steam Packet Co.	Vickers-Armstrong	1930	363·6	50·2	17·4	3104	Twin screw, four geared turbines
"Amsterdam"	L. and N.E.R.	J. Brown and Co.	1930	350·8	50·1	26·2	4200	Twin screw, four geared turbines
"Isle of Sark"	S.R.	W. Denny and Bros.	1932	296·7	42·1	13·9	2211	Twin screw, four geared turbines
"Princess Maud"	L.M. and S.R.	W. Denny and Bros.	1934	319·2	49·1	15·9	2886	Twin screw, four geared turbines
"Prince Baudouin"	Belgian National Railways	Soc. Anonyme John Cockerill	1934	356·1	45·9	24·7	3300	Twin screw, oil engines, twenty-four cylinders

of the early turbine steamer had been a marked advance on the shelter afforded on the paddle boat, the newer geared turbine steamers were invariably provided with shelter decks enclosed with large plate glass windows, making it possible to remain on deck and yet avoid all the sea breezes! So insistent has been this demand that the fine mail steamers built for the Holyhead-Kingstown (Dun Laoghaire) service in 1920–21 (at that time the largest and fastest steamers of their class) have had to be reconstructed with the now fashionable enclosed shelter deck.

For twenty years the geared turbine steamer, with four turbines—or in a few cases six—driving twin screws through single reduction gear, has been the standard type for cross-channel work, with a few notable exceptions, among which may be cited the vessels of the Zeeland Steamship Company, which exclusively maintains its Flushing-Harwich sailings with fast twin-screw packets driven by reciprocating engines, as does the British and Irish line to Dublin.

It was in the year 1929 that the most serious assault was made on the standard vessel, for in that year the Belfast Steamship Company boldly placed on its Liverpool-Belfast service motor vessels propelled by Diesel engines. The three ships "Ulster Monarch," "Ulster Prince," and "Ulster Queen" are of sturdy build, and in general appearance smaller replicas of the motor liners that had previously left the yard of their builders, Messrs. Harland and Wolff; they form a marked contrast to the handsome Heysham steamers which berth near them at Belfast.

The most interesting features of these packets are to be found in the engines, which are of the Harland-B. and W. airless injection four-cycle trunk type. There are two engines, each having ten cylinders of 24·8in. diameter and a stroke of 38·56in. With 160 r.p.m. a speed of 18½ knots is maintained, the total brake horse-power being 6000. The propellers are three bladed and have a diameter of 12ft.

The closely associated City of Cork Steam Packet Company placed a motor vessel of very similar lines, but rather smaller proportions, "Innisfallen," on its Fishguard-Cork service in the following year.

The chief drawback to these boats is to be found in the vibration, apparently so inseparable from Diesel-engined craft, although it is claimed that a bad cabin on a Diesel boat is preferable to a bad cabin on a turbine steamer. It must be borne in mind that the machinery in a channel packet is large and powerful in relation to the size and strength of the hull, rendering vibration troubles very real. If other boats are built for this service the engines will probably be two-cycle ones with cylinders about half the area of the present ones and a much more even turning moment. Lack of balance in the auxiliaries often contributes much to vibration difficulties.

At one time the opinion was freely expressed that while the motor vessel might find a sphere of service on the longer sea passages, it was unlikely that for the shorter sailings the geared turbine steamer would lose pride of place. To those who held that view it came as a shock when the Belgian National Railways, after very careful deliberations, decided to put a large and fast motor vessel on the important passage between Ostend and Dover. In many ways "Prince Baudouin" is a remarkable craft, for she may be of 15·76in., and they are run at 550 r.p.m. There are three electrically driven turbo-blowers for the main engines. Electricity has entirely superseded steam for capstans, steering, heating, ventilating, cooking, &c., so that it is not surprising that about 2000 kW are required. Among many interesting innovations it may be mentioned that the traditional steering wheel is conspicuous by its absence from the bridge, and a special glass of very thick type has been used for the exposed part of the saloon windows. Every effort has been made to minimise vibration, and care has been taken so to place the engines, &c., that there may be no synchronisation of vibrations with hull frequency. In addition, absorbent material has been freely used in the construction of passenger saloons, &c.

The performance of this remarkable mail boat over an extended period will be watched with much interest.

At present the British railways continue to place their faith in the geared turbine steamer, and recently several fine additions have been made to their fleets. Among these may be mentioned "Princess Maud," built last year for the Stranraer-Larne service of the London, Midland and Scottish Railway, for she claims to be the highest-powered mechanically stoked coal-burning mail steamer. Steam is supplied by four Babcock and Wilcox boilers at a working pressure of 225 lb. per square inch, and there is a grate area of 448 square feet.

The same company has this year had launched at the yard of Harland and Wolff, Ltd., another large geared turbine steamer, "Duke of York," for the Heysham-Belfast service. She is 349ft. long by 52ft. wide and has a depth of 19ft. 6in. Her speed is to be 21 knots and she, too, is coal fired with mechanical stokers.

Anyone wishing to compare different types of cross-channel steamers cannot do better than go to Douglas, for there he will find twin-screw reciprocating-engined steamers and triple-screw turbines lying side by side with some of the finest examples of modern twin-screw geared turbine steamer.

In Table III will be found dimensions of a few modern and typical cross-channel packets.

There is one other interesting craft which should be mentioned, that now under construction by Denny and Bros. for the New Medway Steam Packet Company—or rather a subsidiary company registered as the London and Southend Continental Shipping Company. This vessel, which was due for delivery in June, will be capable of carrying 1700 passengers for cross-channel excursions, her point of departure being Tilbury. She will be a twin-screw vessel propelled by Sulzer c.i. engines developing over 3000 b.h.p., and it is intended that her speed shall be about 23 knots. She is being provided with promenade decks sheltered for two-thirds of their length with large plate glass windows, and she should prove to be a very interesting venture.

In a short article it is out of the question to describe more than a few typical cross-channel packets; it is not even possible to name the many examples of the shipbuilder's art; but it is hoped that enough has been said to show that there has been a steadily maintained advance in this particular type of vessel, whether measured by dimensions, by tonnage, by

Crossed axes shaving is a gear tooth finishing operation recently developed to provide an economical means of correcting inevitable errors in the manufacture of spur and helical gears. In the operation the work is rotated only under slight pressure with a special cutter or tool in the form of a helical gear, of which the teeth are gashed so that the tool has somewhat the appearance of a lamina. The work gear and the cutter have different helical angles. The angle made by their axes as set up in the machine is equal to the difference in their helical angles, nominally from 10 deg. to 15 deg., although this range may be extended on both sides of the limits given. The cutter is normally mounted with its centre over the intersection of the axes of the two shafts. To ensure the correct tooth profile and helical angle in the gear being cut, the relation of the axes compensates for the variations in sliding action due to the involute roll. As the gear and cutters are brought together cutting continues towards the pitch line up to the centre point, and in the reverse direction as they pass that point and separate. Thus uniform cutting is assured over the entire tooth profile.

Rail and Road.

PASSENGERS arriving by westbound trains at Sloane-square Station have to mount two flights of stairs, with a total of fifty-one steps, to reach the street. It is now officially announced that the station is to be reconstructed and that the objection will then be met.

THE death, on July 17th, of Sir W. C. Thorne, formerly the solicitor to the Mersey Docks and Harbour Board, reminds us that, on behalf of the Docks and Harbours Association, he gave evidence before the Loreburn Royal Commission of 1913–14 on the Relations between Railways and the State.

ASKED, on July 24th, as to the freeing of streets from horse-drawn vehicles, the Minister of Transport said that to that end he was prepared to consider any proposals which might be put forward by the responsible authorities for their own areas. Further, his Department approached on all suitable opportunities the principal users of horse-drawn vehicles with the object of achieving the more rapid substitution of motor for horse-drawn vehicles in the Metropolis.

IN view of the fact that British railway companies have substituted for the 18in. fish-plate, with four holes, a 10in. plate with two holes, it is significant to read in the Indian Railway Board's report for 1933–34 that the Track Standards Committee had considered the present length of standard fish-plates in India with regard to both economy and efficiency. The Committee, basing its recommendations on extensive experimental data from American railways, recorded that no change in the length of the present fish-plate was desirable. It must be remembered that flat-bottomed rails are used in America and India.

THE London, Midland and Scottish Railway has set up the record for the longest through engine-working in this country. One of the "Royal Scot" 4–6–0 type locomotives leaves Euston at 7.30 p.m. with the "Royal Highlander" express, reaches Carlisle at 1.38 a.m., and refuels before proceeding at 5.16 a.m. with another express to Aberdeen. On arrival at Aberdeen the engine has 2¼ hours before returning to Carlisle with the 1.55 p.m. express fish train. At Carlisle the engine again refuels, continuing to London with the 1.7 a.m. sleeping-car express from Calisle, and arriving at Euston at 7.25 a.m.—thirty-six hours after leaving London. During this period 1079 miles are travelled.

IN reviewing, on page 90 of our issue of July 26th, the annual report on the railway accidents of 1934, we mentioned that 4958 accidents to, or failures of, rolling stock or permanent way were reported by the companies during the year. That figure, we observed, was lower than in any corresponding period mentioned in the report. Most of these were failures of couplings—4679—which heading had been reduced, year by year, from an annual average of 8701 for the years 1925–1929. Broken rails were the next biggest item last year, but as they numbered only 117 the situation must be considered satisfactory. Equally so were the other rolling stock failures, besides couplings: bursting of boilers or tubes of engines, 5; failures of machinery, springs, &c., of engines, 18; failures of tires, 38; failures of axles, 31.

IT was thirty years ago, on July 27th, since there occurred the serious railway accident at Hall-road, on the Liverpool-Southport electrically operated line of the Lancashire and Yorkshire. Twenty-one passengers were killed and so it was, as regards casualties, the third most serious accident of the present century—the two worse being Salisbury, on July 1st, 1906; and Quintinshill, on May 22nd, 1915. Between the two running lines at the Southport end of the station was a middle siding, into which a train from Liverpool had, on the afternoon in question, run in order to be reversed and to return to Liverpool. The next train was an express for Southport, but the signalman had failed to restore the siding points. He could not, therefore, lower his signals, but did not appreciate that they were held by the interlocking. He assumed that an electrical detector on the points was out of order, so he "flagged" the train by, which consequently ran into the standing train. The late Colonel Druitt inquired into the accident and said in his report: "The only lesson to be learnt from this calamity is the very old one of the necessity at all times of complying exactly with all rules and regulations, and that punctuality and fast running must always give way to safety requirements." The latter remark was evidently prompted by the signalman pleading that he was afraid he would be fined if he delayed the express; he had heard of men being so fined.

IN the concluding sentences in our "Sixty Years Ago" in THE ENGINEER of July 26th we had occasion, in discussing a letter which we published on July 23rd, 1875, to mention a collision at Perth. We revert to that subject in order to relate that when Mr. W. H.—afterwards Sir William—Preece read his paper "Railway Telegraphs" at the Institution of Civil Engineers on November 13th, 1863, he was urging the need for efficient apparatus for the working of single lines and said that "On a railway in the North of Scotland a superintendent was himself killed in a collision caused by his own irregular orders." Additionally to the fact that the officer killed was Mr. Craigie, the station-master at Perth, which was a rank lower than that enjoyed by a "superintendent," the working of single lines of railway, as generally understood, did not enter into the question. The line was double tracked, but the up line was undergoing repairs. A passenger train had arrived in the station and it had to go to Bamhill to have the engine turned. Mr. Craigie gave instructions for it to proceed along the down, or wrong, line and himself accompanied the train. The signals were kept "on" against a down goods train, but the driver of the latter ignored them and in the collision which resulted the carriage in which Mr. Craigie was riding was damaged and he was killed. That accident happened on January 19th, 1850. Actually, up to the terrible single-line collision of September 10th, 1874, the only collision on a single line that caused loss of life to passengers was near Craven Arms, on August 27th, 1860, and there only one passenger was killed.

Miscellanea.

SUCCESSFUL laboratory trials having been completed, an experimental plant for the manufacture of formaldehyde from natural gas is being erected in Russia.

WE regret to note the death of Sir Charles Holdsworth, formerly managing director of the Union Steamship Company of New Zealand, Ltd.

THE Pont du Carrousel in Paris is to be demolished and replaced by a wider bridge. The present bridge is only 23ft. wide, and the new structure will have a total overall width of 108ft.

THE board of Dorman, Long and Co., Ltd., has decided to install a cold rolling mill and plant for the production of cold sheet and strip up to 72in. in width at the company's Cleveland works.

AT the opening of the last stretch of undercliff drive between Rottingdean and Saltdean, Sir Herbert Carden said that over £600,000 had been spent in sea defence works on the Sussex coast.

THE longest span concrete arch bridge in the world is in course of construction in Spain. It will carry a double track railway line across the Esla River, and has a total length of 1545ft., with a central arch of 627ft.

THE City telephone exchange, one of the largest in London, was changed over from manual to automatic working on Saturday, July 20th, when the 4600 lines were connected simultaneously to the new automatic equipment.

THE date of the opening of the 1936 Empire Exhibition at Johannesburg, South Africa, has been fixed for fifteen months hence, and a very good beginning has been made with the great programme. Preliminary work in the erection of the series of industrial buildings is well in hand.

THE Department of Overseas Trade announces that arrangements are being made for a portion of the British Industries Fair for 1937 to be housed in the new exhibition buildings which are to be erected at Earl's Court. The remaining portion of the Fair in London will be held, as usual, at Olympia.

A SPECIAL school for the founding industry has been formed, and if there are sufficient students will be opened at Birmingham in September. The school is intended for those engaged in the founding industry who have already had some practical experience, and who wish to qualify for, or have already shown their capacity in, managerial or supervising posts.

THE U.S.S.R. authorities are considering the establishment of an extensive electricity grid, and an operating tension of 400 kV is suggested, says the *Electrician*. The Institute of Electro-physics of Leningrad has been authorised to proceed with the erection of a short experimental line capable of transmitting power up to a pressure of 500 kV, in order to secure data as to the most suitable types of conductors, insulators, and protective devices for use at the high tension proposed.

THE Council of the British Electrical and Allied Manufacturers' Association decided at a meeting held on July 18th that the entire control of the Beama management should be vested in the one director, Mr. V. Watlington. Mr. Watlington has been a joint director since 1932, and now assumes sole responsibility to the Council of the Association for all Beama activities. Mr. C. Rodgers, secretary of the Association since 1921, has been appointed deputy director.

A NOTE in the *Machinist* states that in order to commemorate the centenary of the birth of Gaston Planté the Société Française des Electriciens is instituting a silver-gilt medal to be awarded once in three years for valuable contributions, scientific or technical, to the accumulator, primary battery, or electro-chemical industry. The first award will be made in June, 1937, and with it will go a monetary prize of 4000f. or more. The award is without restriction as to nationality.

IN a paper on "Modern Machine Tool Problems," read by Mr. S. Einstein before the American Society of Mechanical Engineers at Cincinnati, the author states that modern tool-room equipment sometimes does not show more favourably in regard to time saving, when compared with older models, because of the fact that too much time has to be spent in chucking the work piece on the machine for the machining operations. Standardised chucking and clamping equipment for tool-room operations would, he holds, minimise this setting-up time, and with such an improvement in the tool-room methods equal benefit could be obtained with modern tool-room equipment as obtained hourly and daily with modern manufacturing equipment. The amount of energy and ingenuity which the machine tool builder has put into the development of such equipment should be met with more constructive response and co-operation from the user in the full utilisation of its productivity.

DURING the past few years the Admiralty has been carrying out experiments at Singapore on several timbers to test their immunity from or resistance to marine borers. At first experiments were confined to untreated timber, but when in 1931 a plant was installed in England for incising and creosoting Douglas fir by the same process as employed in British Columbia and the Pacific Coast of the United States, it was decided to add creosoted Douglas fir, treated by this process, to the test timbers at Singapore. The logs were fixed in the sea in the Straits of Jahore on July 1st, 1932, and interim reports of inspection indicated that while untreated piles had been heavily attacked, there was no sign of borers on the treated piles. After nearly three years of immersion, the treated specimens show no borings of teredo, although there are a few martesia borings. It should be noted, however, that the logs were the first to be treated in this country by the process mentioned, and the absorption of creosote was not considered satisfactory, and on subsequent occasions progressively better absorption of creosote has been obtained. At the moment it would appear that incised creosoted Douglas fir is most resistant to borers, but it is yet to be seen how long a properly impregnated timber will effectively resist attack.

Air and Water.

A SITE at Whitley has been selected for Coventry's airport scheme.

A NEW daily air service between Paris and Rome has been inaugurated.

PLANS for a new aircraft factory near Wolverhampton have been approved.

PROVISION is to be made for seaplanes in the plans for modernising the Royal Victoria Dock.

CAPE TOWN Harbour has been equipped with up-to-date direction-finding apparatus for ships.

AN American seaplane is reported to have reached a height of 18,200ft., carrying a load of 24,000 lb.

THE British gliding duration record has been claimed by Mr. J. C. Neilan, who remained in the air for 13 hours 7 minutes.

THE London to Newcastle air race was won by Flight-Lieutenant J. B. Wilson, flying a B.A. "Eagle" at an average speed of 141·5 m.p.h.

WE have received from the City of Hull Development Committee a copy of a time table of air services, both internal and international, in connection with the municipal airport.

A BRITISH Percival aeroplane fitted with a Rengnier engine and piloted by M. Guy de Chateaubrun won the French Grand Prix race from Deauville to Cannes on Sunday, July 21st.

THE naval construction programme of the Greek Government provides for the building of twelve destroyers. Construction is to be spread over a period until 1940 and international tenders are to be considered.

A NON-STOP flight from Moscow across the Arctic to North America and then *vid* Banks Island and Vancouver to San Francisco is to be attempted by a single-engined Russian aeroplane carrying a crew of three.

THE Anchor-Donaldson Line, Glasgow, which was an associate company of the old Anchor Line before the latter was taken over by the Runciman group, will be known in future as the Donaldson Atlantic Line, Ltd.

ACCORDING to a report, Crilly Airways, Ltd., is shortly to inaugurate a new service which will place Norwich, Leicester, and Nottingham in direct communication with Liverpool, Blackpool, Belfast, and the Isle of Man.

THE announcement is made by the West Indian Company, Ltd., St. Thomas, Virgin Islands, that the harbour basin adjoining the 3000ft. dock at St. Thomas will be deepened to a minimum depth of 33ft. The dredging will be shortly completed.

A NEW world's non-stop flight record for seaplanes is claimed for an Italian monoplane fitted with a 750 h.p. Isotta Fraschini engine. The flight, from Montfalcone, near Trieste, to Berbera in British Somaliland, a distance of 3104 miles, was made in 24 hours 55 minutes.

A SCHEME whereby the launching of ships from a slipway may be abolished is to be tried out at St. Nazaire. Vessels will be laid out in what is virtually a dry dock on a horizontal bed and when completed they will be floated by flooding the dock and then towed out into the river.

THE R.A.F. Short Singapore III flying boat "K4581" recently covered the distance of 1070 miles from Plymouth to Gibraltar in 14¼ hours, flying non-stop. This machine is on its way to Singapore to replace the flying boat which crashed in Italy when on its way out to the Far East.

ON Wednesday, July 17th, Count Raczynski, the Polish Ambassador in London, performed the ceremony of laying the keel and closing the first rivets of one of two torpedo-boat destroyers being constructed by John Samuel White and Co., Ltd., at East Cowes, for the Polish Government.

AN order has been placed by the Siamese Government with the Cantieri Riuniti dell'Adriatico for two mine-sweepers. The builders have already in hand two submarines for Siam. It is understood that shipowners in Trieste will shortly place an order with the Cantieri Riuniti for three 18-knot passenger and cargo motor liners for the South African service.

AN agreement has been made between Imperial Airways and the Compagnie Générale Transatlantique for an aeroplane to connect at Plymouth with each arrival of the second named company's liners from New York. This air connection will enable passengers for most European destinations to save considerable time by catching the morning air service from London.

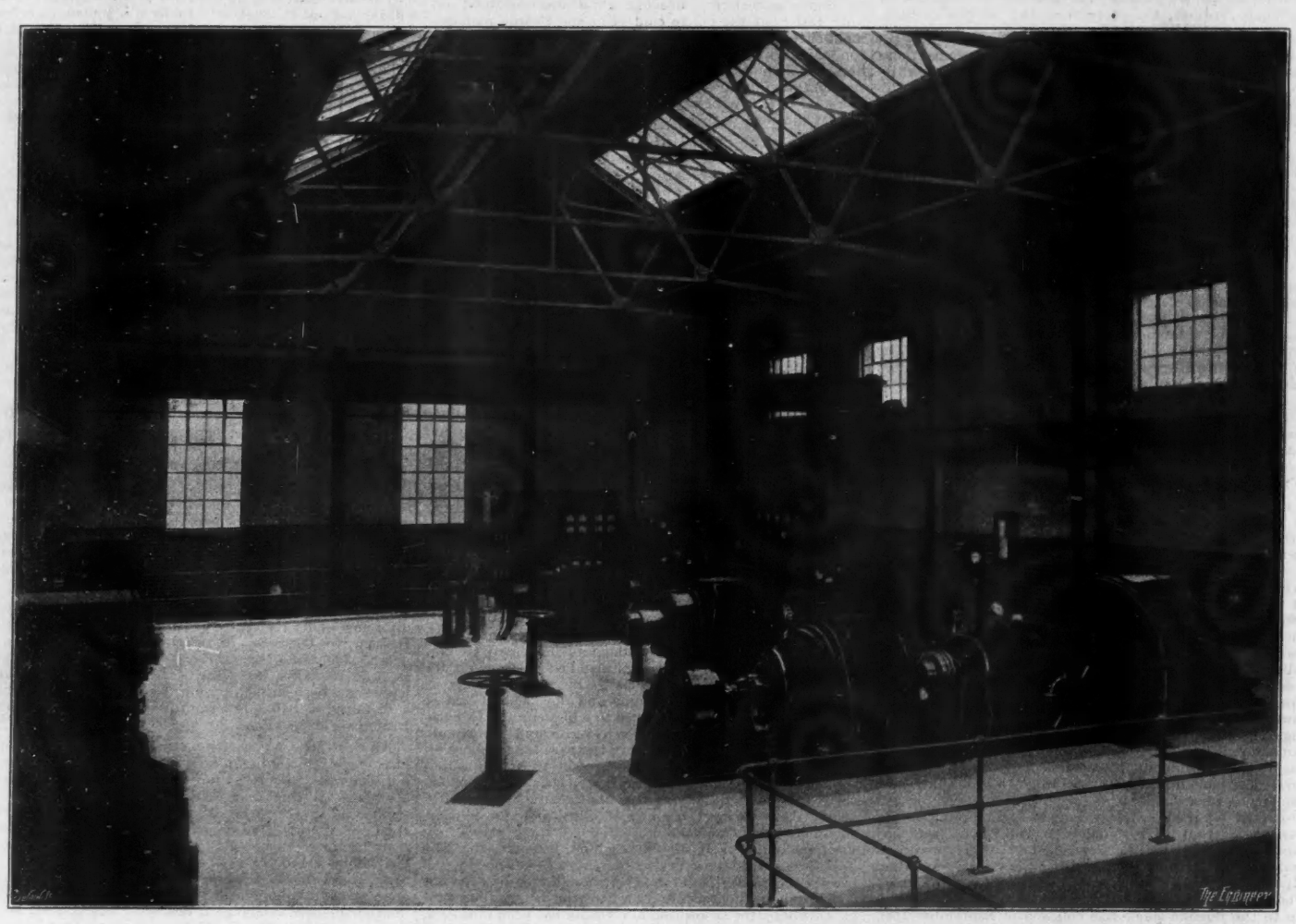
ACCORDING to the findings of the Wreck Commissioners' inquiry into the loss of the 4218-ton steamer "Millpool," which sunk with twenty-six hands in the Atlantic on October 23rd last, the vessel's loss was due to the perils of the sea, and, in particular, the weather in which she sank. The loss was not caused or contributed to by the wrongful act or default of her owners or her manager.

A GERMAN airman, Herr Ludwig Hoffman, recently set up a new glider record by a flight from the Wasserkuppe, Hessen, to Olesnice, in Czechoslovakia, a distance of nearly 300 miles, or nearly 75 miles further than the existing record of last year. This record is reported to have since been broken by four German pilots who glided a distance of 310 miles from Wasserkuppe, Hessen, to Brno, Czechoslovakia.

AT one of its recent Council meetings, the Institution of Naval Architects requested Mr. R. W. Dana, the retiring secretary, to stay on for some months. As announced elsewhere in this issue, the Council now requires the services of a secretary. Applicants for this post should, the Council states, possess a University Degree or equivalent training, with literary ability for editorial work. Candidates should be between thirty and forty-five years of age, and should have organising and travelling experience, while a colloquial knowledge of French and that of another modern language is desired. The Council invites written applications for this post, accompanied with full particulars of the candidates' career and with copies of testimonials, to be sent to the Council of the Institution, 2, Adam-street, London, W.C.2, before the end of August.

EXTENSIONS TO THE DAVYHULME SEWAGE WORKS, MANCHESTER

(*For description see page 109.*)



ABOVE:—AIR DIFFUSION TANKS

BELOW:—INTERIOR OF COMPRESSOR HOUSE

The Engineer

AUGUST 2, 1935.

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NOTICES TO READERS.

*** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

CHANGES OF ADDRESS.

*** *Will subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses**, *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

"SPECIAL" AREAS IN SCOTLAND.

LAST week we discussed Mr. Malcolm Stewart's Report upon the Special Areas in England. A few days after its appearance, Lt.-Col. Sir Arthur Rose's Report on the Special Areas in Scotland was published. It is a document of a very different kind. Whether that difference is due to the areas themselves or to the outlook of the Commissioner, we are unable to say. Mr. Stewart examined principles and their relationship to facts; Sir Arthur deals only with what he has done, states very few facts, and shows little interest in the principles which underlie industrial depression. Hence he leaves upon the reader the impression that none are involved and that all that is needed is patience and sufficient temporary help to carry the special areas in Scotland triumphantly to complete rehabilitation. He neither hints nor suggests that there is anything in the geographical or social conditions of the areas to account for the fact that they are suffering more from industrial depression than other parts of Scotland. He may be perfectly right, but we could wish that he had presented arguments in support of the view which he seems to hold. Mr. Stewart endeavoured to discover why certain areas of England are failing to recover as rapidly as other parts; Sir Arthur Rose appears to have thought that in Scotland no such investigation was necessary. If it ever occurred to him that there must be a reason for local depression, he dismissed the discussion of it as outside his "terms of reference." Apparently he took the view that he was appointed to administer about one million pounds and that he was not expected to take a philosophic view of his duties. Whilst we cannot quarrel with him for his interpretation of his orders, yet we feel regret that he has not examined his areas with the object of discovering the root of the trouble, or that, if he has actually done so, he has not presented his findings in this Report.

We need not detail the areas for which Sir Arthur is Commissioner; it is sufficient to say that they constitute that district, with Glasgow as its natural centre, which is known as the Industrial West of Scotland. Glasgow itself is excluded from his purview. Much has been said about this area in the last few years, some of it very severe, some very pessimistical. There are not wanting those who assert that the leaders in it have lost their enterprise and enthusiasm. We should have valued a detached statement on that opinion, which we are ready to believe may be wholly without good foundation. As we said last week, unemployment is a symptom, not a disease; unless we can get at the cause of the ailment we cannot hope to effect a cure. Hence we regret that Sir Arthur has regarded his functions as those of a Relief Officer rather than of a doctor. He took it, he says, that they might be separated into ameliorative activities and—"much more difficult, requiring intensive study"—constructive activities. The insured population in his areas number 328,270, and on June 24th 26·8 per cent. were unemployed. He had, he writes, "to deal with a surplus of labour amounting (in very rough figures) to approximately 60,000 men and boys, of whom some 40 per cent. may be regarded as the first reserve force for industry, another 40 per cent. consisting of older and less adaptable persons, as a second reserve, and the remaining 20 per cent. as verging, owing to age and other considerations, on the unemployable category." This is substantially a repetition of a paragraph from Sir Arthur's report to Mr. Oliver Stanley in 1934 on Depressed Areas in Scotland. Rigidly resisting temptation to incur "dissipation of energy in theoretical investigations likely to add nothing to the solution of the problem, but another volume of statistics and good intentions," he grouped his work into five categories: (1) plans which prepare the way for economic and industrial development; (2) plans for stimulating existing and attracting new industries; (3) plans for finding alternative careers; (4) labour questions; and (5) social service schemes. We have no doubt that he conceived his mission to be of the very practical nature which this schedule indicates. Nevertheless, his attitude towards "theoretical investigations"—as he dubs them—reminds us of the contrast between the practical detective and the philosophical detective who figure in certain well-known crime books. It is the philosophical detective who solves the mystery. Let us, however, run no risk of presenting Sir Arthur Rose's activities in a wrong light. He does devote a page or two to industrial investigation and says in conclusion of that part "The field of Economic Planning and Research is so important to the nation as a whole that it appears to me there may be room for an authoritative Scottish Body with suitable experience and knowledge, equipped with an expert staff, financed by the Government, and endowed with powers to *explore industrial conditions*, make recommendations, and in general aim at introducing into our economic structure that element of orderly and planned development which in the past has in some considerable measure been overlooked." The italics are ours.

We have contrasted the reports of these two Commissioners—the one discussing causes before proposing measures of amelioration, and the other refusing to investigate causes but going direct to his task—but we are not prepared to say which best meets the letter of his instructions. It is possible that Mr. Stewart went outside his prescribed duties and that such investigations and reflections as he made should be left to an *ad hoc* body like that adumbrated by Sir Arthur. We do not know. But we do know that the problem of local unemployment can never be solved until its cause has been ascertained. In some cases the cure, as Mr. Stewart suggests, is the heroic one of excising the hapless district from the industrial map. Other districts can probably be brought round either by the "orderly and planned development" in which so many, with Sir Arthur Rose, believe; or, as many others believe, by the newcoming of strong personalities as in the past. We are disposed to believe that all planning can ever do is to make easier the path of the strong personalities. But the selection of the district will always remain with the individual, and to persuade him to go to one if he was convinced that it was unsuited to his industry would either be vain or disastrous.

Foreign Trade Developments.

IN its relation to foreign trade, the agreement which was concluded in Brussels between British and Continental steel makers is of greater importance than would seem to be implied by an adjustment of interests in a particular industry. It is a successful attempt to adapt industrial dealings to new and particularly involved conditions of international trading that have resisted all efforts to simplify them and restore vitality to European industry. The idea of a steel organisaton originated in Germany a few years after the Armistice, when German steel makers raised the spectre of Europe being swamped with American steel. At that time United States producers had been exporting steel in a manner that appeared to justify those fears, but the Steel Cartel actually came into existence when Europe suffered from a disorganisation of its own industry, and ruin could only be averted by steel makers combining to maintain prices in home and foreign markets. The fact that since then circumstances have changed so much for the worse, suggests that there is little hope of any general plan being readily applied to remedy a bad situation. Such a plan will assuredly be laid eventually on a foundation of international agreements, and so long as there is no other immediate way out of the difficulty the solution appears to lie in a co-operation of industrial interests, the effectiveness of which is shown by the example of the Steel Cartel which has survived all vicissitudes, and is now the only workable organisation that can give hope of success. Great Britain has a commanding position in neutral foreign markets, because it is backed up by an economic structure, including domestic, Empire and sterling sources of supply and demand. As in the case of steel, Continental trade tends to be drawn within the British orbit, and the necessities which have brought about the steel agreement will, it is anticipated, prove equally strong in promoting collaboration in other branches of industry.

One reason for believing in an early change in the Continental trade outlook is the obvious failure of the economic fallacy underlying the efforts of most countries to create artificially industries which they regard as essential to their material wealth and political power. That idea constitutes the basis of national self-sufficiency. In France it was carried to the extent of encouraging makers to produce every type of foreign machine required in the country, with the result that want of experience when embarking upon such manufactures had the effect of lowering efficient production and throwing discredit upon some classes of home-made goods similar to those that had formerly been supplied by foreigners. That prejudice has been partly removed by technical organisation and by experience acquired, often at great cost, but the machinery industry has now attained a position which enables it to resist any policy which may involve too great a sacrifice of its interests. Yet some sacrifice must be made if Governments, that are now grappling with financial problems, are to succeed in their efforts to restore that industrial and commercial activity which can alone save them from disaster. The policy of self-sufficiency has dried up all sources of revenue, and the French Government is driven to declare that facilities must be provided for an expansion of imports and exports, whereby national financial resources can be increased by an interchange of goods and products and by the prosperity of home industries, depending more or less on foreign trade. How to attain that object is a problem that perturbs the French, who are anxious to escape from an intolerable situation. Any solution of the problem is surrounded by all kinds of difficulties arising out of currency fluctuations, embargoes on currency exports from some countries that prevent traders in other countries from getting payment for goods supplied to them, and now the German plan to subsidise exports by means of funds provided by the different branches of industry concerned, has placed a further obstacle in the way of removing quotas and other barriers behind which gold countries are intrenched. At the same time, no country can wholly sacrifice industries that have grown up under a system of abnormal protection, but those industries must be content with less protection if they are to find some activity in a general trade recovery. In machine tools nothing will be allowed to destroy the results that have been achieved abroad by the expenditure of much capital in developing an industry that tends to be marked by national characteristics and a deviation into types which, under ordinary competitive conditions, may constitute progress in particular directions. Industry is becoming more varied in its productions, and with freer exchanges there will be greater facilities for trade, without unprofitable competition in similar products. All the elements for an industrial organisation in Europe exist if only they can be gathered together into a complete plan, but for a long time to come such a

general plan is out of the question. It can only be brought gradually into shape by partial agreements which will eventually fit into a new system of European trade and industrial expansion.

The Anglo-Continental steel agreement may be regarded as the first stage in a series of similar undertakings affecting different industries. Its significance lies in the fact that it has smoothed away difficulties that appeared likely to prevent any durable international arrangements through failure to bring into line all European producers in a particular industry. Had Poland not adhered to the Steel Cartel, there would have been little prospect of settling the delicate matter of reducing the tariff on steel imported into Great Britain without extending the same privilege to countries outside the Cartel enjoying most-favoured-nation treatment. The renewal of the Rail Union has further strengthened the idea of grouping European industrial interests, and it appears probable that an attempt will be made to regulate exports of coal from different countries on similar lines. When dealing with engineering industries, the conditions required to insure the successful working of such schemes are more complex. Arrangements were at one time made between groups representing particular branches of engineering in France and Germany for an exchange of products, but they were not acceptable to the French Government, which feared that partial arrangements would clash with other negotiations then in progress. Those negotiations shared the fate of all efforts that have been made to deal with the problem on a broad basis. A vast amount of preparatory work, mainly of a financial character, will have to be undertaken before Continental countries can settle down to the real task of putting the European economic machine in motion, and, meanwhile, there is grave danger of countries suffering a collapse from which they will recover with difficulty. French industrialists have all along persisted in the belief that the only way of dealing with the situation is to promote collaboration amongst particular industries in different countries for an exchange of similar, though not directly competitive, goods at pre-arranged selling prices. Such arrangements would enable the industries concerned to tide over the long and difficult period of economic reconstruction, which might indeed be shortened by confidence arising out of the fact that manufacturing industries had succeeded in returning to something like normal trade conditions. There are difficulties in the way that can only be removed by industrial arrangements covering all producing countries. There can be no hope of such arrangements being carried through successfully without the co-operation of British producers, who hold the key to the situation, and the satisfactory results achieved by the Steel Cartel suggest, at least, that the Continental idea of industrial agreements for an interchange of products may be worth consideration.

The North-East Coast Institution of Engineers and Shipbuilders.

No. II.

(*Concluded from page 95, July 26th.*)

THE reading of papers connected with the celebration of the jubilee of the Institution was continued at Armstrong College on Thursday morning, July 18th, an alternate visit to Durham Cathedral and its Deanery being arranged for the ladies attending the meeting. Five papers summarising developments in the construction of marine engines during the past fifty years were taken. The subject of marine turbines was ably dealt with by Mr. R. J. Walker; that of reciprocating steam engines by Mr. Summers Hunter, jun.; boilers by Mr. T. McPherson; and marine heavy oilengines by Mr. K. O. Keller. Mr. G. S. Swallow dealt with recent progress in electrical and general engineering.

In his paper on "Marine Steam Turbine Development during the Past Fifty Years" Mr. Walker recalled that it was in 1885, exactly fifty years ago, that the manufacture of the compound turbine was begun. Up to 1892, however, in spite of savings in size and weight, the then comparatively high steam consumption of the turbine was such as to prevent its application for marine propulsion. In 1894 Sir Charles Parsons laid down the 100ft. vessel "Turbinia," which in 1897 made a speed of 34½ knots at the Royal Naval Review at Spithead. The steam consumption of the machinery at full power was 14½ lb. per i.h.p. hour. During the period under review, which had included the application of both the direct and the geared turbine drive to all classes of naval and mercantile ships, for both high and slow speeds, about 50 million horse-power of marine steam turbines had been constructed throughout the world. A culminating point of marine turbine design was, Mr. Walker said, the construction of the machinery for Britain's first high-pressure warship, H.M. destroyer "Acheron," which has an output of about 34,000 s.h.p. The British Admiralty decided upon a boiler pressure of 500 lb. per square inch, with a total steam temperature of 750 deg. Fah., as compared with a boiler pressure of 300 lb. per square inch and a total steam temperature of 600 deg. Fah. in the other vessels of the class. The "Acheron" set up a new record in fuel economy for steam propelled naval vessels, the oil fuel consumption on the full-power trial being 0·608 lb. of oil per s.h.p. per hour for all purposes, the water consumption 7·77 lb. per s.h.p. per hour, or equivalent to about half the figure of steam consumption obtained in the days of the earlier installations. A high fuel economy was also obtained at reduced powers, namely, at 60 per cent. of full power the oil fuel consumption was 0·675 lb. per s.h.p. per hour and the water consumption 7·93 lb. per s.h.p. per hour. At 10 per cent. of full power the oil fuel consumption was 0·92 lb. per s.h.p. per hour, and the water consumption 12·87 lb. per s.h.p. per hour, these figures of oil and water consumption being for all purposes. Mr. Walker observed that whatever the future might have in store for the turbine, it could be said that the rapid succession of events in its comparatively short history had produced, in the words of one writer, a story of an enterprise so fascinating and so far reaching in its ultimate power as to bring it almost within the realms of fiction.

In the paper on the "Reciprocating Marine Steam Engine during the Past Fifty Years," Mr. Summers Hunter, jun., dealt only with engines for cargo ships; the application of such engines to passenger ships and naval vessels having been ably dealt with by Engineer Vice-Admiral Skelton in the Institution's 1932 Andrew Laing lecture. The leading types of machinery designed between 1885 and 1935 are described and illustrated and performance figures given. In the last ten years Mr. Summers Hunter sees more activity in technical improvements in marine reciprocating steam engines than at any other period. Improvements have included several different arrangements of exhaust steam turbines working in conjunction with the engine, and improvements in valve design with a view to utilising higher degrees of superheat. Taking the engines of the "Iona" and "Meteor" as an 1885 basis and a modern 200–220 lb., 600 deg. Fah. engine to represent present-day conditions, and taking the 1885–1890 heat consumption basis as 100, then the 1935 basis is 85 per cent. and with an exhaust turbine about 70 per cent. The net result of hull and machinery improvements made during the period is summarised in the table reproduced below. In this table is given the first six months' performance of six cargo vessels fitted with compound engines in about 1885; the same for six vessels of about the same date (1885) fitted with triple-expansion engines; and finally that of four vessels built in the last year or two and driven by modern triple-expansion engines working on superheated steam without exhaust turbines, but otherwise of a good up-to-date specification.

Date.	Machinery.	Average speed.	Average displacement.	Av. coal per day.	Av. coal coefficient.
1885	Compound	8	3,600	12½	9,400
1885	Triple-expansion	8½	4,500	12½	13,300
1934	Triple-expansion	9½	10,500	17½	23,250

It appears from the above table that the past fifty years has seen a reduction of 50 per cent. in the fuel expenditure necessary to drive a given displacement at a given speed; this reduction is the combined result of improvements in hull, main engine, auxiliary machinery, boilers, propellers, and is due also, in large measure, to the close co-operation which to-day exists between owner, shipbuilder, and engine builder when the interdependent details are being decided.

The paper given by Mr. T. McPherson on "Marine Boiler Development in the Past Fifty Years" deals with boilers for both naval and mercantile vessels and is noteworthy for the fine series of drawings of cylindrical and locomotive type marine boilers. The newer composite types, Prudhon-Capus and Howden-Johnson boilers, and the latest developments in water-tube boilers, are also described and illustrated. Concluding his paper, Mr. McPherson referred to the far-reaching effects of the use of fuel oil instead of coal in the boiler furnaces. Fifty years ago, he says, the steam jet type of oil burner was generally in use, but in modern boiler installations of large capacity the pressure system is now standard practice. Modern design of oil firing equipment had been perfected to ensure high rates of burning in restricted combustion chambers by burning large quantities of oil per burner, the combustion air being intimately mixed with the oil spray to obtain rapid heat release. Such a condition in boilers in which the heating surfaces are so distributed as to ensure rapid absorption of the heat generated permits of high rates of burning with relatively low gas volume, and correspondingly low air pressures. Air preheaters now play an important part in maintaining the high overall efficiency of boiler plant by recovering heat which would otherwise be lost in the funnel gases, and raising the combustion air to a temperature valuable for supporting combustion in furnaces in which brickwork tends to play a smaller part in supporting combustion. Boiler efficiencies calculated on the gross calorific value of the oil of the order of 88 per cent. are now being obtained.

In his paper on "Marine Oil Engine Development during the Past Fifty Years," Mr. K. O. Keller traces the development of the marine oil engine and the advance made in design, combustion, and fuel injection with corresponding reductions in size, weight, and fuel and lubricating oil consumptions. The four-stroke engine was predominant until about 1932, when there was a general change over to the two-stroke type. By means of an interesting heat balance chart Mr. Keller shows that, taking the heat supplied to the engine in the fuel oil as 100 per cent., that converted to b.h.p. is now 41·2 per cent., whereas in 1897 it was only 26 per cent.; the heat carried away in the cooling water is now 19·4 per cent., compared with 31 per cent. in 1897; the heat rejected to exhaust 36·4 per cent., compared with 40 per cent. in 1897; while the unaccounted losses remains at 3 per cent.

The utilisation of the heat in the exhaust gases has received renewed attention since 1934, particularly in two-stroke engines, in which the temperature of the exhaust gas is generally lower than in the four-stroke type owing to the chilling effect from the excess of air necessary to ensure complete scavenging of the burnt product. By passing the exhaust gas through an efficient waste heat boiler sufficient steam is generated to operate a lighting set, steering gear, and occasional auxiliaries, whereby an overall gain in fuel consumption of 15 to 20 per cent. has been recorded. Several such installations by William Doxford and Sons, Ltd., of the "Sutherland" class, designed to carry 9200 tons at 11 knots, port to port, consume only 6·19 tons fuel per day, or 0·325 lb. b.h.p. per hour. These vessels are driven by three-cylinder opposed-piston oil engines of the all-welded construction, developing 1800 b.h.p.

Immense advances have been made in design and types of oil engines, likewise in materials available for their construction; it is therefore not surprising to observe that the most economical prime mover should find ever-increasing favour for marine propulsion, and now represents over 60 per cent. of the total tonnage at sea in the comparatively short period of twenty-five years, thus well deserving reference on the occasion of the jubilee meeting.

In his paper on "Recent Developments in Electrical and General Engineering," Mr. M. G. S. Swallow dealt in a broad and interesting way with the developments in the period under review and the present and future outlook in industry on the North-East Coast. We print this paper on page 127 of the present issue.

A vote of thanks to those who had so ably prepared and presented the jubilee papers was proposed by the President, Dr. John T. Batey, and was seconded by Mr. C. Waldie Cairns, the Chairman of the Reading Committee. In the course of his speech Mr. Cairns said that in its concern about the depressed condition of shipbuilding the Committee had perhaps tended to forget both the actual and potential activities in other engineering fields, such as locomotive building, bridge building, the manufacture of coal cleaning and mining plant, and several lighter industries. Perhaps if a little more had been said about them and what they did, Mr. Cairns added, manufacturers of similar products might consider the possibilities of establishing themselves in the district to utilise the skill of its fitters and turners.

After luncheon at the University Union there was a motor run to Rothbury, which gave visitors an opportunity of seeing something of the Cheviot Hill country. Tea was taken at the County Hotel, Rothbury.

In the evening there was a civic reception and dance at the Old Assembly Rooms, and the Lord Mayor and Lady Mayoress, Councillor and Mrs. R. Stanley Dalgliesh, received the guests.

Friday, July 19th, was devoted to a whole-day visit to the Roman Wall, which was prefaced by a short lecture at Armstrong College by Mr. Ian A. Richmond, the lecturer in Romano-British Archæology. An opportunity was taken on Friday to welcome the American delegate, Rear-Admiral George H. Rock,

of Washington, President of the Society of Naval Architects and Marine Engineers of New York. A very enjoyable day was spent and luncheon was served at the George Hotel, Chollerford, and tea at Hexham. In the evening, at 8 p.m., in the Grey Hall of Armstrong College, Sir Westcott Abell, Professor of Naval Architecture in Armstrong College, gave the Citizens' Lecture with the title "Ships Through the Ages." At the conclusion of the lecture the Institution party and its guests again met the President and Mrs. John T. Batey in the University Union for light refreshments. So ended a memorable jubilee meeting, which took place in most appropriate weather and which was made very enjoyable by the excellent arrangements made and carried through by the Secretary of the Institution, Mr. E. W. Fraser-Smith, his assistant, Mr. Nichol, the staff, and the Jubilee Meeting Committees.

Industrial Sub-Station Equipments.

By F. C. BAUMANN, A.M.I.E.E.

THIS short article is an attempt to collate the most important general factors which should influence the design of the laying out or grouping of industrial sub-station equipments.

Each lay-out of equipment of the nature being dealt with here must, of course, primarily depend on the various special factors of type and size of unit affecting its own particular case, but some general aspects of the laying out of the plant may be either overlooked or given insufficient consideration, and it is hoped that these notes will assist in keeping all necessary points in view so that the best final result may be obtained.

The suggested arrangements apply more especially to the sub-station portion of equipments, as the location of motors and their controls for the actual drives is generally fixed by mill or factory requirements.

The principal conclusions are that the following appreciable advantages accrue from a timely study of the best lay-out for each particular plant :—

(*a*) Economy in cost of buildings, and connecting cables or bare copper connections.

(*b*) Improved operation, leading to economy in running costs and maintenance.

(*c*) Economy in future extensions by carefully considered provision for these in advance.

(*d*) Correct selection of types of plant and connections in the tendering stage.

It is obviously necessary to be guided by the special factors of the case under consideration, such as the nature and dimensions of the items of plant, space may be effected by placing plant in a building with two floors or a single floor with a gallery. Switchboards and small auxiliary plant are usually quite suitable for installation on a gallery or upper floor without modification of design, and cabling to such items should present no difficulty.

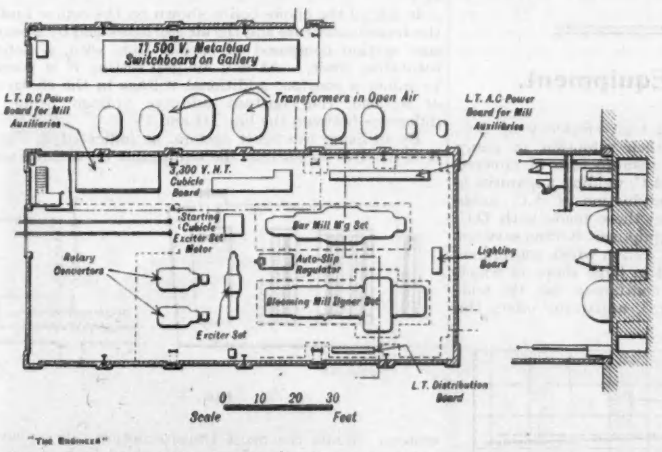
Saving in the initial cost of cable or bare copper connections should also be kept in mind, especially in the case where these are of heavy section for large currents. The items of plant so connected should be relatively located to keep the length of runs to a minimum, compatible with a practical lay-out. This economy in length of connections will also help to reduce voltage drop which is often a consideration.

In cases where transformers are used in sub-stations they are often the tallest unit, but they can be put in a pit 3ft. to 4ft. deep without appreciably affecting their ventilation. This would probably save copper by shortening the L.T. connections, and would also enable the core to be lifted out for inspection with the minimum of crane head room and height of building. This mainly applies to rotary converter transformers.

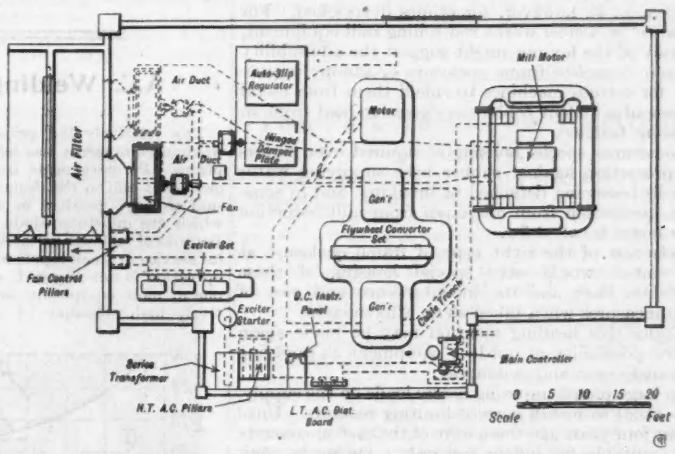
In cases where sub-stations are built in industrial areas and space is limited or cost of ground is excessive, they can be designed with a basement for transformers and heavy switchgear which can be hand or remote controlled from above.

(2) IMPROVED OPERATION.

Careful study must necessarily be made of the location of the main mill control points in any mill



LAY-OUT OF PLANT IN SUB-STATION OF PRETORIA WORKS



LAY-OUT OF REVERSING ROLLING MILL IN JAPAN

available, and any particular necessities of locating or grouping of items.

The necessity for careful consideration of a lay-out design can be classified under the following main headings :—

(1) Economy.
(2) Improved operation.
(3) Erection and maintenance facilities.
(4) Appearance.

(1) ECONOMY.

Economy can be studied in respect of the type of building, and the present-day tendency in industrial plants is to simplify and cheapen the type of housing structure, using possibly a more highly protected design of plant, and, in the extreme case, to adopt plant installed in the open air.

The comparative merits of different housing structures, however, and the different corresponding design, lie outside the scope of this article. In this connection it is worth noting that one class of plant is readily adaptable to outdoor location without appreciable increase in cost, namely, transformers.

A bank of transformers of outdoor design can be placed in the open alongside the machine house. The saving in cost may be appreciable if the span of the building is reduced thereby. Transformers of the size and capacity we are considering do not need a crane for erection purposes, and can be wheeled into the machine house to be served by the crane for repair purposes.

A saving in floor space, in order to keep within fixed limits or to reduce the size and cost of the building, equipment, and care should also be expended in the laying out stage to ensure that all the various subsidiary controls are situated in the best position.

In a mill sub-station and the mill itself, all instruments essentially concerned should be in good view from the control point when starting up or regulating any item or section of plant, and, when feasible, the machine or apparatus so controlled should also be in view.

Control gear, whether mounted on switchboards or occurring as separate units, should be collected conveniently, and so placed as to economise time and energy for the operator during a starting-up or shutting-down period. If there should be a regular sequence for starting, stopping, or regulating, a definite order in the physical position of such units is highly desirable.

Selection of position should also tend to encourage the necessary routine attention, and out-of-the-way locations chosen for economy of space should be avoided, if there be any risk of neglect in consequence.

(3) ERECTION AND MAINTENANCE FACILITIES.

A definite amount of space is required for dismantling plant, be it machines, transformers, or switchgear, for purposes of overhaul and repair, and this required space must be allowed for when making the lay-out.

There must be adequate floor space available for any part, such as a machine magnet frame (top half) or armature or switchgear truck, and it must be conveniently near and within service area of the crane. This dismantling space must be fully considered when deciding the clearances between items of plant and run of gangways through the machine room. It must be sufficient to allow the part to be deposited temporarily and leave space around it for working or walking.

The same dismantling space should be sufficient during the stages of original erection of the plant, even if all items are being erected simultaneously, as it is generally quite easily arranged for the parts of any large machines or switchboard to follow from temporary local storage, or from direct transit, in correct sequence to suit the order of erection. Any congestion on actual site is therefore avoided.

Wisely selected clearances between items of plant and straight gangways will assist maintenance.

Clearances must be considered from the standpoint of their purpose. This may include :—

(*a*) Room for extensions.
(*b*) Access for mere inspection during normal operation.
(*c*) Access and passageway for operating staff.
(*d*) Passageway for plant, such as transformers, switchgear trucks, or oil switches on tank-lowering gear in transit from working position to point of inspection, overhaul, or repair.
(*e*) Space for dismantling.

It is unwise to suggest definite dimensions for clearances, as they obviously depend on a variety of factors. A rough idea, however, may be helpful. For the above-mentioned purposes :—

(*a*) The necessary space is that required by any additional unit or units in the future.

Consideration should be given as to the most convenient direction for such future extensions, both in respect of the plant itself and of the building.

Considerable forethought in the matter of space for possible future extensions is advisable, as it may save an inconvenient and unsightly lay-out later on when extending, and the consequent unnecessary expense.

Where future items of plant are related, such as motors, rotary converters, transformers, and their controlling switchgear, space for extensions should be so selected as to economise in cost of connections and suit the scheme of operating control.

(*b*) Bare passageway is needed ; minimum clearance, say, 1ft. 6in.

(*c*) Ample passageway is needed ; minimum clearance, say, 2ft. 6in.

(*d*) The minimum depends on plant unit dimensions.

(*e*) Ditto.

(*f*) An additional case is where no clearance at all is necessary, as in the case of certain types of metal-clad switchgear which require no back access. These can go hard up against a wall. Consideration should, however, always be given to the advisability of leaving a small space, say, up to 6in., for cleaning purposes. Some types of sheet metal cubicles or control desks are designed with louvred openings at front, back, or sides, to assist natural ventilation. In such cases clearances must be selected to suit.

The limits suggested above depend, of course, on the type and size of plant units.

This question of clearance between items of plant or between items of plant and wall is affected by the provision or otherwise of hand rails. Most machines are so provided, and any lay-out should include the consideration of the satisfactory nature and location of hand-railing for all machines in the building.

Clearance dimensions decided upon as necessary for the above-mentioned purposes should be found adequate for any unit of plant in respect of its ventilation. Assuming the unit to be naturally or self-ventilated, care should be taken to ensure that the path of air flow to and from it is not restricted, with the possibility of an appreciable increase of temperature on that account.

Examples of actual lay-outs are shown in the accompanying diagrams.

The first shows the lay-out of the plant in the Ilgner house sub-station of the Pretoria steel works of the South African Iron and Steel Industrial Corporation,

which was put into service early in 1934. This lay-out is typical of some of the features mentioned in this article, namely, use of a gallery for switchgear, the outdoor location of transformers, and the use of a basement for run of cables and bare copper connections.

It may also be mentioned that a ventilating plant in the mill alongside the sub-station supplies filtered air into the basement, which discharges through openings in the pits under the various large machines.

The second diagram shows the lay-out of a reversing rolling mill equipment installed in Japan. In this is indicated the run of air ducts for the mill motor, which is forced ventilated.

(4) APPEARANCE.

The appearance of a group of plant is by no means a negligible factor. From the æsthetic point of view, there is, of course, the natural desire on the part of both maker and user that the plant should look as well as possible. It is hardly necessary to say that there should be uniformity, regularity, and symmetry in the arrangement wherever possible, as any unwarranted departure from this would look obviously wrong when designing the lay-out.

Furthermore, there are the psychological aspect and benefits to be gained from a well-arranged and orderly lay-out. Better and more pleasant working conditions have a beneficial effect on the care bestowed on the plant by the operating staff and attendants, resulting in better operation, greater freedom from breakdown and longer life of the plant.

GENERAL POINTS.

Kindred to the whole subject of plant lay-out are two major points which should be taken into account at an early stage :—(1) The type of plant to suit best its location, and (2) the type of cable or other style of connections to be used between items of plant.

(1) *Type of Plant.*—Where the plant being laid out is to be erected in a sub-station or separate machine room, probably no special study of the type of the machine or apparatus is necessary. But when the items of plant are to be placed in a mill or factory building and in proximity to other machinery or plant, there may be conditions that will influence the type of machine or control unit.

Normally, all units are specially selected as regards frame enclosure to suit their particular duty and location from ordinary open type through various degrees of protection to total enclosure. The effect of location is, however, sometimes overlooked. For instance, in a steel works rod-rolling mill equipment, a study of the lay-out might suggest the advisability of more complete frame enclosure or canopy protection for certain machines to shield them from metal in case of a violent cobble, or excessive heat from an adjacent furnace.

Sometimes special housing is required over motors for protection against rubber hose supplying water to rolls becoming detached or breaking, and in some cases protection from oil fumes from mill reduction gear-boxes is called for.

Selection of the right type of frame enclosure at the outset would save special housing of these machines later and the inconvenience and cost of such measures when taken as an afterthought.

Under this heading mention may be made again of the possibility of outdoor equipment as applying to transformers and switchgear.

In large plants imposing heavy loads on the supply, it is usual to install current-limiting reactors. Until about four years ago these were of the cast-in-concrete type suitable for indoor use only. Owing to their characteristic of having a high degree of uncontrolled leakage flux, it was not possible to place them in close proximity to iron stanchions or other magnetic metal work. The advent of the oil-immersed reactor having a controlled leakage flux has overcome this difficulty, and this apparatus may now be installed out of doors in exactly the same way as a transformer.

Saving in housing expense by means of outdoor type of plant should be given adequate consideration at an early enough stage in the whole scheme.

(2) *Type of Connections.*—There will be a certain degree of freedom of choice as to the type of connections and method of running, when the lay-out is decided on, as after the electrical considerations of voltage, &c., the chief determining factors are the type of building and the lay-out itself. At this stage, therefore, choice should be made of the most suitable method of running the connections and the best type of connections themselves.

Methods of running connections comprise :—

(*a*) Open floor trenches with chequer plate covers.
(*b*) Culverts of large size to permit through access, or small earthenware ducts for cable to be pulled through.
(*c*) Basements.
(*d*) Overhead.
(*e*) Any combination of the above.

The type of connections will depend on the method of run selected and their duty. They can consist of bare copper strip on porcelain insulators for heavy currents or cable of suitable type, or a combination of both. The chief feature to bear in mind regarding cable runs is ample spacing to permit of careful and neat erection, and ease of access to any particular cable for maintenance.

A cable run must suit the particular units being served. For example, a trench for cables connecting into a machine or a machine set would run into machine pits or alongside the machines to suit the normal position of machine terminals. Likewise, a cable trench for switchgear would run in front of, under, or behind the switchgear units, with small auxiliary tee ducts, if necessary, to suit the position of incoming and outgoing connection points inside the units.

Any item of plant requiring forced ventilation will, of course, necessitate air trunking between itself and the fan. Such air duct may be sheet metal trunking above floor level, but is more likely to be formed in the concrete foundations and floor below floor level. The run of such air ducts must, of course, be considered during lay-out design, when below floor level they are usually run below the cable trenches where they cross or coincide.

(3) *Earthing Requirements.*—As all plant operating above "low pressure" (110 volts) has to be earthed to comply with Home Office regulations, it is necessary to bear in mind the requirements of the earthing system. This will comprise one or more earthing points, conveniently situated, each with earth plate and prepared soak-away of rolled ashes, together with the run of earth strip or stranded conductor to such points from all items of plant.

CONCLUSION.

In scheming most equipments it is likely that at least a preliminary lay-out is made at an early stage for tendering purposes and preliminary building design, and that later a final lay-out will be considered and decided upon when the plant has been ordered and detail drawings of the various items are available.

The author hopes that the few suggestions in this paper may be useful on either of these occasions, and considers that a lay-out should take as definite a form as possible at the earlier stage, so that tendering can be on the basis of a well-considered arrangement, with consequently few modifications necessary in the finally matured plan of the equipment and its lay-out.

For kind permission to use as examples for this paper, the lay-outs of plant on which the diagrams are based, the author is indebted to the English Electric Company, and in the case of the first also to the South African Iron and Steel Industrial Corporation and to Merz and McLellan, who acted as consulting engineers in the case of this electrical equipment for the Pretoria steel works.

A.C. Welding Equipment.

THE relatively low price and high efficiency of A.C. welding equipments has led to their adoption in many places. Progress made in the manufacture of covered electrodes and in the design of A.C. welding apparatus is said to have resulted in the production of A.C. welds which are indistinguishable from those made with D.C. Because of its lower price, A.C. equipment is often selected for service in small repair works, &c., in which continuous operation is not required, whilst in large shops in which one or more equipments are in continuous use, the relatively high efficiency of the A.C. apparatus offers the

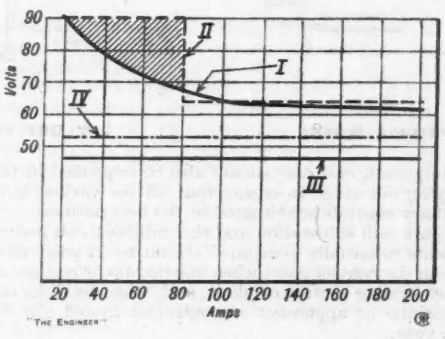


FIG. 1

advantage of current economy. While the efficiency of an A.C. welding transformer is from 85–90 per cent., that of a D.C. equipment is from 50 to 60 per cent., and where a large amount of welding is done, the smaller losses of the A.C. equipment are naturally desirable. The power factor can easily be maintained at 0·8 or higher, with the aid of static condensers.

A design of A.C. welding equipment brought to our notice by Mr. C. E. Fries, consulting engineer to the Hackbridge Electric Construction Company, of Walton-on-Thames, is claimed to offer several advantages. To overcome the difficulty of starting and maintaining the arc when welding with small currents, the no-load voltage must be relatively high. When welding thin sheet with about 15 ampères, the no-load voltage must be about 90, whilst for a current of, say, 150 ampères the no-load pressure must be about 60 volts. Apart from the fact that high voltages at low currents are undesirable from the point of view of safe operation, they increase the size and cost of the apparatus and lower the efficiency. Generally the no-load voltage variation is obtained by means of tappings in the transformer, selected by plug-in contacts or a switch giving 80–90 volts for light work and 60–70 volts for heavy work.

Investigations have shown that the most favourable minimum values of the no-load voltage are a function of the welding current, and the relative voltage curve is shown at I in Fig. 1. In a transformer provided with tappings, the relative voltage values are represented by the curve II, and it will be noted from the hatched portion that a considerable range of the operating currents are then obtained at a much higher no-load voltage than is necessary for perfect work. The main advantage claimed for the transformer under consideration is that a no-load voltage curve is obtained in line with the curve I, the

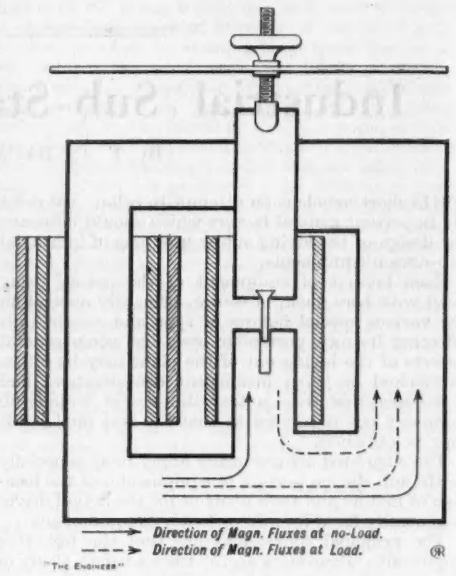


FIG. 2

transformer secondary being connected in series with a choke coil, which allows the setting and limiting of the welding current. The disposition of the transformer windings, choke coil, and paths of the magnetic fluxes are such that there is a voltage induced in the choke coil at no-load, which is additive to the secondary voltage indicated by the line III, the difference between the voltage I and III being supplied by the choke coil. Thus, by varying the air gap in accordance with the welding current, the voltage induced in the choke coil will also vary, and together with the secondary voltage will produce a resultant voltage curve, similar to that indicated at I.

In Fig. 2 the choke coil is shown on the centre limb of the transformer core and the air gap is bridged by a narrow core section composed of special iron with a definite saturation limit. At any air gap setting it is possible to induce a constant additional voltage in the choke coil at no-load, the constant additive voltage being the difference between the line III and IV.

By utilising the Scott system, as indicated in Fig. 3, it is possible to operate the equipment on a three-phase

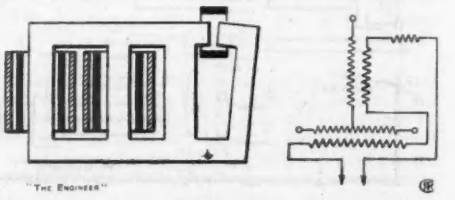


FIG. 3

system. While the Scott transformation takes place in two limbs of the transformer, the third limb carries the larger magnetic flux ($x\sqrt{3}$), the choke coil being arranged around the variable air gap. By the use of static condensers the loading of the three phases can be more or less equalised.

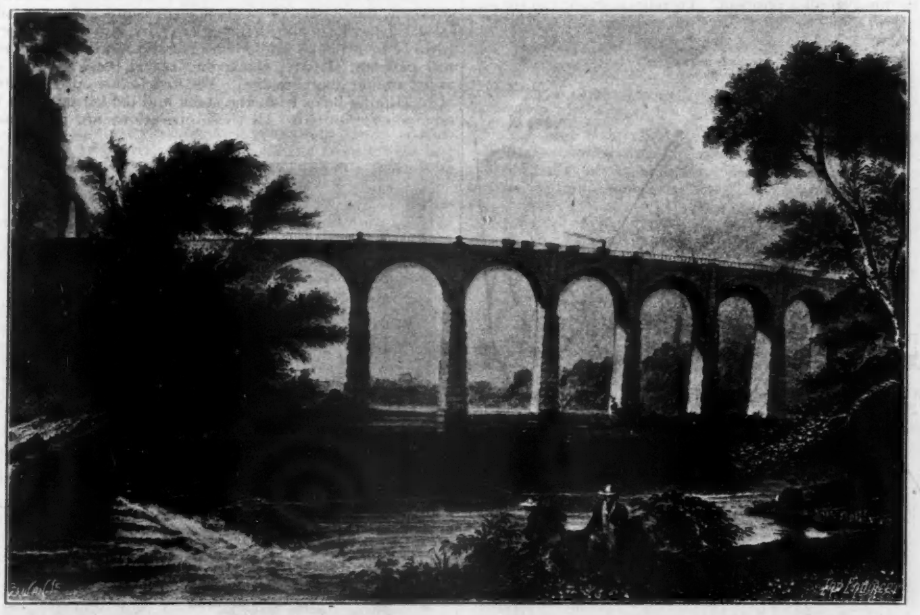
Between the limits for which the apparatus is designed, the regulation of the welding current is continuous, and for any current between, say, 20 and 200 ampères, the correct no-load voltage is automatically obtained. Owing to the absence of tappings, the equipment readily lends itself to remote control. When used on bridges and ships, on which the equipment is usually a considerable distance from the job, the welder can set the transformer to any desired current, and can regulate the arc without leaving the job. As the additional voltage is obtained from the choke coil, the necessary no-load voltage can be obtained with a relatively small voltage on the transformer winding and the resultant fewer turns needed give reduced dimensions and better power factor and efficiency. Experience with this welding transformer is said to have shown that it has excellent welding characteristics, and it operates satisfactorily with any make of electrode.

A NOVEL method of sinking foundation caissons through soil to rock has been adopted in the U.S.A. According to *Engineering News-Record*, the caissons from 4ft. to 8½ft. in diameter and averaging 66ft. in length, are clamped to a rotating head held at the top of a tower rig, resembling a pile driver, and as the head turns them the saw-tooth cutting edge at the bottom of the cylinders cuts down to the rock base through 65ft. to 70ft. of sand, clay and small boulders. Progress of sinking varies according to the soil, but has been found to average between 12ft. and 20ft. an hour; the caissons are thus sunk in four to six hours, as compared with the usual six to eight days required under compressed air methods on similar work in New York.

ONE HUNDRED YEARS OLD STONE VIADUCT IN AMERICA

Centenary of a Stone Arch Viaduct.

ONE hundred years ago on July 4th, 1835, a jubilant Irish contractor and his gang celebrated in liberal draughts of whisky the completion of the Thomas Viaduct across the Patapsco River, in the State of Maryland. That day the structure had successfully demonstrated its ability to carry the six-ton trains of the Baltimore and Ohio Railroad without crashing into the river far below. In triumph, McCartney, the contractor, at his own expense, erected a monument nearby and inscribed upon it the names of the directors of the railway and those of important persons in the State of Maryland and the City of Baltimore. Lastly, he added in two places his own name, so that he could be certain that those who came after should know by whom the bridge had really been built. Now one hundred years later, the Thomas Viaduct still spans the Patapsco River. The bridge remains almost untouched, as the builders left it, and the heavy main line expresses of the Baltimore and Ohio roar across it! Verily McCartney built a structure stronger than his wildest boasts had claimed! The viaduct, which is curved in plan, consists of eight elliptical arches with clear openings that vary in length from 57ft. 10½in. to 58ft. 4½in. It has a total length of 617ft., a maximum height of 60ft. and a width, sufficient for two sets of rails, of 26ft. It was designed by Benjamin H. Latrobe, an architect of Baltimore, and is built of native granite. An engraving at the head of this page contrasts the kind of train it was designed to carry with the modern expresses now using it. Nor is the other engraving without interest. It is a reproduction of a contemporary picture, published in England, and is notable for the "pictorial" distortion of the proportions of the bridge. At one end of the structure can be seen McCartney's monument. To-day, photography gives us a more correct, though less picturesque impression.



CONTEMPORARY PICTURE OF THE THOMAS VIADUCT

An Electro-deposition Exhibition.

BY permission of the Director, Colonel E. E. B. Mackintosh, an Electro-deposition Exhibition is being held at the Science Museum. It was opened by the Rt. Hon. Lord Melchett on Thursday, July 25th, and it will remain open for the public until the end of October. Organised by the Electro-depositors Technical Society, the Exhibition has been designed to illustrate to the layman all the phases of electro-deposition and the scientific principles upon which it is based. Valuable help in its preparation has been given by the British Non-Ferrous Metals Research Association, the Research Department, Woolwich, the Royal Mint, and leading industrial firms.

Certain electro-deposition processes were carried out in the early years of the nineteenth century, but the subject was first investigated systematically by Michael Faraday, who laid the foundations of the modern science of electro-chemistry. To-day, electro-deposition plays an important part in various industries, and its use in connection with beautifying common metals and rendering them less susceptible to tarnish and corrosion is demonstrated at the Exhibition. The importance of electro-deposition applications can be gauged from the fact that the production and refining of metals by electrolytic means in industry involves the consumption of 11,000 million kilowatt-hours per annum. Over 1,000,000 tons of copper, 200,000 tons of aluminium, and 14,500 tons of nickel are said to be produced annually by the electrolytic process.

The applications of electro-deposits in familiar industries, such as those devoted to the manufacture of motor cars, cycles, plumbing fixtures, general hardware, domestic silverware, telephone, and wireless equipment, &c., are demonstrated. Other exhibits show electro-deposition as applied to printing, gramophone record production, the deposition of non-metallic substances, the electrolytic extraction and refining of metals, and the chemical colouring of metals. For the benefit of the technician there are exhibits demonstrating recent research, which has been carried out by three classes of workers—independent workers, chiefly in universities and technical colleges; large industrial corporations and supply houses professionally interested in the electro-deposition industry; and Government research establishments. The research exhibits cover methods of estimating adhesion and stresses in deposited metals, resistance to corrosion, and thickness of structure. Various methods for the control of solutions and testing of the finished deposits are illustrated, and apparatus is shown for investigating various problems.

The Exhibition is designed mainly to show two things—how electro-deposition is carried out and what can be done by the process. Models and diagrams explain the principles of the process. A small demonstration model is to be seen actually plating specimens with nickel and copper. Another exhibit shows the chemicals required to prepare the plating solutions used for the common metals.

Two motor generator sets, as used for producing the current required for electro-deposition, are on view. The more modern method of obtaining low-tension D.C. from A.C. mains by means of a metal rectifier is demonstrated. Small examples of the more usual types of plating sets are to be seen, together with models of some of the modern types of vats and a working model of the latest type of fully automatic plating plant. There are small examples of the plant used for cleaning and removing grease and dirt from the articles to be plated. A cinematograph film, shown at intervals, illustrates some of the modern methods of electro-plating.

What can be accomplished by electro-deposition and allied processes is shown by the remainder of the exhibits. Examples of electro-plating with almost any metal that can be deposited have been included in the Exhibition. The examples demonstrate both those finishes which are designed to improve the appearance of the metal and those deposits which are designed to act specifically as protectives and prevent the basis metal from corroding. Examples are shown of special thick deposits used for protection against wear and for building-up worn or under-sized machine parts. Electro-forming exhibits consist of a parabolic searchlight reflector built on a glass mould, copies of art objects built on moulds taken from the originals, tubes, wires, and domestic utensils, &c. The processes by which printing plates are reproduced and the manner in which stampers for gramophone records are made are demonstrated, and examples of printing cylinders built from deposited copper and faced with chromium to decrease wear are on view.

In the section devoted to extraction and refining processes by electrolytic means there are examples of practically all the metals that are refined electrically, together with process diagrams and models of cells. Various processes for producing coloured surfaces on metals are to be seen. Among them are the anodising processes used for oxidising and colouring aluminium. Various coloured finishes produced by chemical and electro-chemical methods on brass and copper specimens are included in this section.

Two-Part Tariffs for Electricity Supply.

A COMMITTEE appointed by the Federation of British Industries, under the chairmanship of Mr. J. S. Highfield, for the purpose of considering the possibility of obtaining greater uniformity in the basis of two-part tariffs as used in connection with supplies of electricity for general industrial purposes, has recently issued a report indicating its conclusions. This form of tariff is not recommended or preferred to other alternatives, as, for example, flat rates, and it is recognised that certain important classes of load can, in fact, only be secured by offering flat rates or block tariff charges.

Interchanges of electricity charges which have been carried out by the Federation from time to time have shown, however, that a material proportion of the electricity supplied for general industrial purposes is sold on some form of two-part tariff, but that these tariffs show wide dissimilarity in principle (apart from questions of actual price), that they are often imperfectly understood by the consumer, and may give rise to much dissatisfaction. It was felt, therefore, that in cases where two-part tariffs provide the only or accepted basis of charge, a standardisation of the general principles adopted would be advantageous to both the consumer and the supply undertaking. After making a careful survey of current practice, the respects in which standardisation was considered to be desirable were:—(*a*) The integration period employed in the measurement of maximum demand; (*b*) the type of maximum demand indicator to be used for the purpose; (*c*) the character of the power factor adjustment; (*d*) the period of account during which a charge in respect of the maximum demand should continue; (*e*) the coal price adjustment; and (*f*) the proportion of energy allowed for lighting use.

As a result of discussions subsequently undertaken with the four associations which represent the supply undertakings, substantial agreement has been reached on five of the above questions, whilst in regard to the sixth—item (*d*)—though there appears to be no possibility of obtaining complete unanimity at the present time, a very considerable measure of agreement has been secured. The position is summarised in the following paragraphs, but it should be noted that some undertakings specify a minimum capacity of the installations to which the conditions should be applicable.

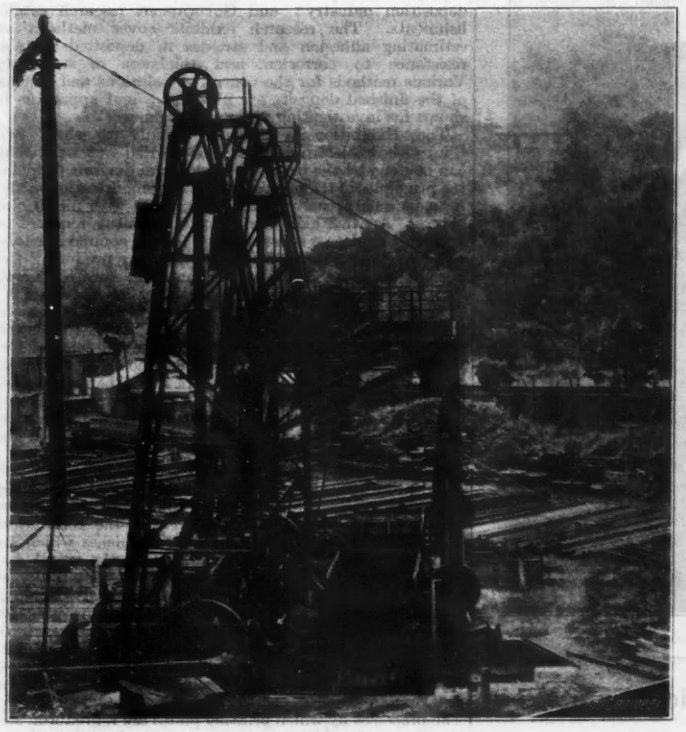
(*a*) It has been agreed that an integration period of thirty minutes should be used.

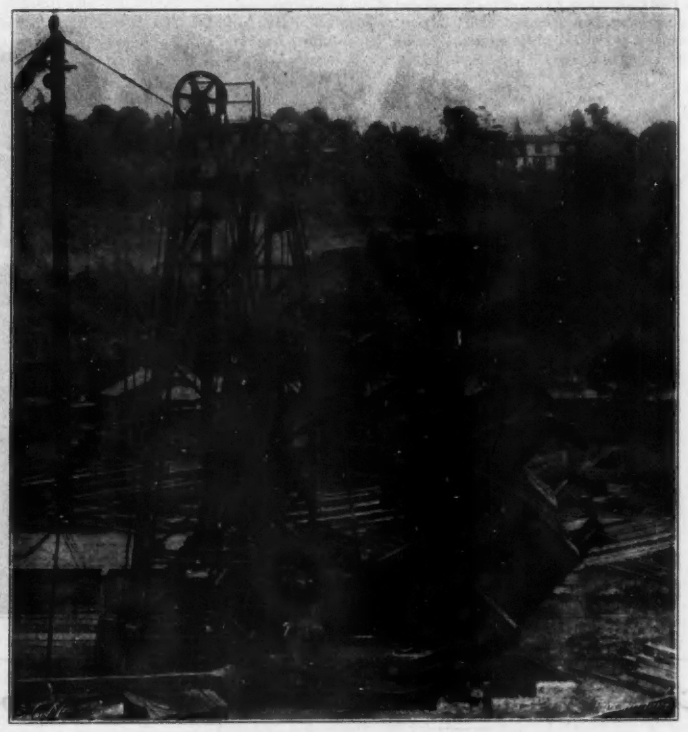
(*b*) It is undesirable and impracticable to specify any particular type of instrument, but it is agreed that the indicator used should record with a satisfactory degree of accuracy the maximum average load as measured during successive thirty-minute periods.

(*c*) It has not been found possible to obtain absolute unanimity, but there is a very large measure of agreement that the power factor adjustment should be applied automatically by measuring the maximum demand in kVA.

SIXTY-TON SIDE DISCHARGE WAGON TIPPLER

FRASER AND CHALMERS ENGINEERING WORKS (G.E.C.), ERITH, ENGINEERS





(*d*) This is the point on which it has not been possible to obtain complete agreement. A substantial proportion (probably a majority) of the supply undertakings is already prepared to make separate maximum demand charges in respect of separate monthly measurements, but others insist that in view of the arrangement between themselves and the Central Electricity Board, whereby their own maximum demand charge is on an annual basis, they must reserve the right to charge their consumers in a similar way; in the latter cases it is thought that there may be some relaxation, in actual practice, giving greater latitude to the consumer outside the peak load periods in November, December, January, and February, and this concession would be of material advantage in many cases.

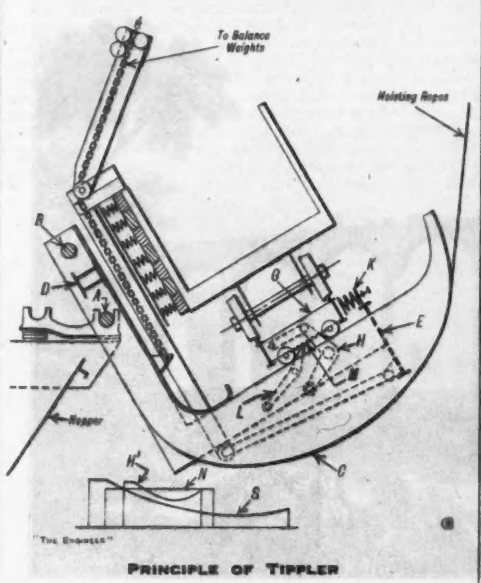
(*e*) The coal price adjustment is to be in accordance with the C.E.B. scale for the particular area concerned, with an addition of 10 per cent. for losses in distribution; thus, where the C.E.B. scale is at the rate of $\pm 0{\cdot}0008$d. for each penny variation in coal price, the consumer's adjustment would be at the rate of $\pm 0{\cdot}00088$d.

(*f*) In order to meet the criticism that the conditions of ordinary industrial use should be more clearly specified, it has been agreed that the installed capacity of the lighting equipment should not exceed 20 per cent. of the capacity of the whole installation, but that within the limit of this maximum capacity there should be the uniform charge for both power and lighting, which then can be supplied from one set of mains.

A Large Wagon Tippler for China.

A PARTY of engineers recently visited the Fraser and Chalmers works of the G.E.C. at Erith, Kent, for the purpose of inspecting a large Marshall wagon tippler built for China. It is for use on the Lunghai Railway and is designed to handle wagons having a maximum capacity of some 40 tons, or a gross weight of 60 tons, the wagon itself weighing about 18 tons. Trucks of 40 tons capacity can be handled at the rate of ten per hour or, as will be the more usual case, 20-ton trucks at the rate of twenty per hour, although, if required, 40-ton trucks can readily be tipped at the latter rate, thus giving a total capacity of 800 tons per hour. Measured over the body, the 20-ton trucks are 29ft. 6in. long and have a tare weight of 10 tons, while the length of the 40-ton trucks is 42ft. 8in. and the tare approximately 18 tons. The machine is designed to tip one or two 10-ton trucks at the same time and is operated by a 75 h.p. D.C. motor.

Views of the complete machine as erected at the Erith works are given above, while the annexed drawing explains the general principle. The main tippler frame consists of a pair of curved lifting arms, each having a pair of hoisting ropes. These curved arms are connected by a back girder D and a front girder E with stiffening cross members and bracing. Each lifting frame has two pins A and B and in the first place the frame rotates about the pin A which carries the wagon well over the receiving hopper. The final rotation takes place about the pin B, and this double point of rotation reduces the fall and breakage of coal in the process of discharging. The wagon cradle G is mounted on eight rollers to run on the cross beams and is positioned and its speed of side travel is governed by a pair of bell cranks H with one arm of the lever linked to the cradle itself, while the other operates on the cam face H^1, shown separately, and built in practice into the foundations. Four springs K mounted on the girder E exert a force to start the cradle moving forward at the beginning of the tipping operation. To release the weight of the cradle acting on the hornstays of the wagon when in the tipping position a pair of pawls L mounted on the cross girders engage with a tooth rack M fastened to the cradle. This engagement takes place when the cradle has rotated through approximately 12 deg. and is controlled by the cam N. During tipping the wagon side is supported on a bolster composed of wooden blocks of approximately 3ft. by 6in. face and lapped like a brick wall. As each block is supported by three springs the pressure on the side of the wagon is more or less evenly taken and no damage is done to fittings or projecting details. A spill plate at the back of the bolster is run the full length of the tippler and is carried down to the cross beams to form a trough to catch coal should it spill in the early stages of tipping over the ends of low wagons. The coal is later tipped into the hopper when the wagon is in its final tipping position. To relieve shock the double



PRINCIPLE OF TIPPLER

bearing for the two-point rotation is mounted on thick demantine pads. During the tipping operation the wagon is automatically clamped by six clamping bars, each interlaced by a chain and ropes. One end is anchored to the main frame and the other to the balance weight, and an even twelve-point support is given to the top edges of the wagon to sustain it when it is in the tipped position, the clamping bars being free to slide through the main frame to adjust themselves to the heights of the wagons and are controlled by a roller acting on the cam face S.

The time required to tip and return is approximately 45 seconds up and 45 seconds down, and 90 seconds are required to change the wagons, representing twenty tips per hour. The hoisting drums are 42in. in diameter. They are driven through steel spur gear and 21 to 1 totally enclosed worm gear and give a hoisting speed of 50ft. per minute. The 75 h.p., 750 r.p.m. driving motor is a protected type fan-ventilated shunt-wound machine with interpoles. It operates at 230 volts, but the field coils are excited at 120 volts. Ward-Leonard control has been adopted and the motor generator set consists of a 65-kW, 230-volt, 960 r.p.m. compound-wound generator coupled to a 110 h.p., 960 r.p.m., 350-volt, three-phase, 50-cycle protected type slip-ring motor and a 8¼-kW, 120-volt, 960 r.p.m. exciter, which provides the current necessary for the brake magnet and contactor coils in addition to that for the generator field.

Use of Bale Stacking Trucks by L. M. S Railway.

AN interesting application of the latest type of bale stacking equipment to railway purposes is reflected in the installation by the London, Midland and Scottish Railway, at their depôt at Frizinghall, Yorkshire, of two bale stacking trucks manufactured by Wingrove and Rogers, Ltd., of Liverpool. These trucks are designed so that they will pick up, elevate, stack, and travel bales of wool or other similar merchandise. The trucks are also capable of reclaiming bales from the stack and delivering them to any point required. All these operations are performed

BALE STACKING TRUCK

by one man, who travels on the truck, as shown in the illustration. The trucks are constructed to lift bales up to weights of 5 cwt. each, of a size averaging 2ft. 6in. wide by 2ft. 6in. high by 5ft. long, and to stack these bales five tiers high. Carrying a full load, the trucks will travel at a speed of 5 m.p.h. on the level and will lift 5 cwt. at an average speed of 1ft. per second. The dimensions of the trucks enable them to pass through a doorway 7ft. high and 3ft. 8in. wide. Brakes are fitted on the two driving wheels and are normally "on" until the pedal is depressed by the operator standing on the truck platform. An automatic solenoid brake, operating on the worm shaft of the winding drum, holds the load in any intermediate position when the power is off.

Power is supplied from a 32-volt battery, and the motors, which are 1·4 h.p. for hoisting and 1·0 h.p. for travelling, are of the totally enclosed type, series wound.

The hoisting motor is connected to the winch by means of an enclosed worm reduction gear, while the travelling motor drives on to the road wheels by means of roller chains.

The batteries, which are "Exide" type, are designed to operate the truck under average conditions of lifting and travelling for six hours on one charge. A discharged battery can be changed for a charged battery in a very few minutes. We are indebted for the foregoing description and accompanying illustration to Mr. C. R. Byrom, chief operating manager, L.M.S. Railway, to whose requirements the equipment has been installed under the supervision of Mr. C. E. Fairburn, electrical engineer, L.M.S.

Testing Plant for Motor Car Engines.

A NEW electrical plant for running in and testing the engines of 10 and 12 h.p. motor cars has been installed in the Longbridge Works of the Austin Motor Car Company, Ltd. It consists of twenty-six testing sets made by the General Electric Company, Ltd., and twenty-four of them are arranged in two lines, as shown in the accompanying illustration, while the remaining two, which are for testing

TEST PLANT FOR MOTOR CAR ENGINES

sports car engines running at a maximum speed of 4500 r.p.m., are arranged separately. Of the twenty-four sets illustrated twelve are for testing 10 h.p. engines, and the remainder for 12 h.p. engines. Each set consists of a D.C. machine used either as a generator or motor, a direct-coupled tachometer, and a control pillar housing the control equipment. As soon as they are assembled the engines are brought to the testing department on an overhead conveyor track. On arrival the engine is lowered on to one of the test beds, when the water, oil, and petrol supplies are connected up and the engine is coupled to the testing machine. Petrol and oil are fed to the engines from a central source, the consumption of petrol averaging 3000 gallons per week. Five special generators provide the ignition current, while cooling water, maintained at normal working temperature, is circulated by a pump from reservoirs to all the test beds.

Before the actual tests are made the testing machine is caused to drive the engine at low speed in order to run it in. After a suitable lapse of time the ignition is switched on and the engine starts to drive the machine, which acts as a D.C. generator and feeds current back into the supply mains. The engine is then run at higher speeds to obtain normal working temperatures and the horse-power absorbed by the generator is indicated on a meter. After the engine has been running for two hours the speed is reduced to a low value in order to make adjustments. The engine is then tested over the whole range of speed at full throttle and the power developed is again returned to the line. During this test the output and speed of the engine are shown on an ammeter calibrated in horse-power and an electrical tachometer. A 10 h.p. engine has to develop 20 h.p. and is subjected to rigorous inspection before it is assembled in the chassis.

To comply with the fine speed adjustments necessary the testing machines had to be of the D.C. type, and as the works are supplied with A.C. it has been necessary to install a 500 h.p., 500 r.p.m. synchronous motor generator set for converting the A.C. into D.C. at 220 volts. The D.C. testing machines thus take their supply from or feed back into the D.C. side of the motor generator.

Each of the testing machines is designed for a speed range on load of 1000–3200 r.p.m. and is controlled from an adjacent control pillar containing a double-pole isolating switch in the base of a double-pole line contactor, a push button operated face-plate starter, a main shunt wheel regulator, and a vernier shunt field regulator for giving fine speed regulation. Overload and overspeed relays are also provided. Emergency stop push buttons installed at convenient positions operate a dynamic braking contactor. Other equipment in the control panel consists of a tumbler switch for controlling the engine ignition circuit, an ammeter calibrated in horse-power, and a speed indicator. Interlocks render the sets safe in the hands of unskilled operators.

The machine is started as a motor by means of the hand-operated starter and drives the engine for the purpose of running in at the desired speed. By switching on the ignition of the engine and opening the throttle the machine automatically acts as a generator. Speed variation and load are controlled by the main and vernier shunt regulators. To stop the set the operator returns the starter to the "stop" position, thereby tripping the main contactor and the ignition switch. If the main contactor were tripped alone all the load would be thrown off the engine, which would therefore race, and the ignition circuit is therefore broken simultaneously. In cases of emergency the operator can press a button mounted close to the engine and the machine is rapidly brought to rest by dynamic braking. The tripping of either the overload or overspeed relays also brings the machine to rest, and an indicator shows which relay has operated.

The two high-speed testing sets work in a similar manner, although the higher maximum speed has entailed certain modifications in the machine design. To raise the critical speed well above the maximum running speed the machines have been provided with heavy shafts and the commutators are reinforced with steel rings shrunk in position over micanite insulation. A resistance incorporated in the control system enables the machine to be run at low speeds on load and then changed over to the line. Another difference between these high-speed machines and the others is that a patented compensated wattmeter is used instead of an ammeter calibrated in horse-power, so that the power of any engine can be indicated accurately irrespective of the varying speed losses in the testing machine.

Insulated Containers for Meat and Fruit Traffic.

THE L.M.S. Railway has recently built at its Earlestown Works twenty covered containers known as the "F.R." type, which are insulated and constructed for the carriage of meat or fruit. They are built of timber throughout,

L. M. S. INSULATED CONTAINER

insulated with "Alfol," and are fitted with two bunkers in the roof to contain solid CO_2, which is used as a refrigerant. During the fruit season loose wooden floor grids and frames are used for packing the fruit baskets, while on the completion of such traffic the loose fittings are taken out, and galvanised meat hooks are fitted to rails attached permanently to the roof of the container. The main structural members are of Australian hardwood, the subsidiary members being of deal. The outer sheeting is of deal boards, and the inner lining of plywood, between which is placed sheets of aluminium foil for insulating purposes. The roof is double and is insulated in a similar way, as also is the floor. The containers are provided with double hinged side and end doors, the latter at one end only. To ensure that these doors are air-tight spring-loaded leather sealing strips are fitted along all edges, which compress together on closure.

The solid CO_2 bunkers are arranged for roof loading and are themselves insulated on all faces except the base, on which are fixed large aluminium cold distribution plates, which are in direct contact with the "dry ice." The gas given off by the process of sublimation is led away to atmosphere to ensure that no leakage occurs into the container, where it might have deleterious effects on the contents. The interior of the container is finished with two coats of varnish, while the exterior is painted white and is equipped with the usual lifting gear. The whole is carried on a specially constructed steel underframe. These containers were designed by Mr. W. A. Stanier, Chief Mechanical Engineer, L.M.S.R.

British Freight Rolling Stock.

IN connection with the visit to this country of a delegation from the Dominion Parliaments, the Central Legislature of India, and certain of the Colonies, an exhibition of the latest types of freight rolling stock was arranged by the British railway companies, and took place at Euston Station on Thursday, July 25th. No less than twenty-seven examples of vehicles of modern design, including containers, open and covered wagons, and wagons for exceptional loads, were drawn up on platforms No. 6 and 7, and were inspected with keen interest. We have dealt

FIG. 1—"A" TYPE CONTAINER

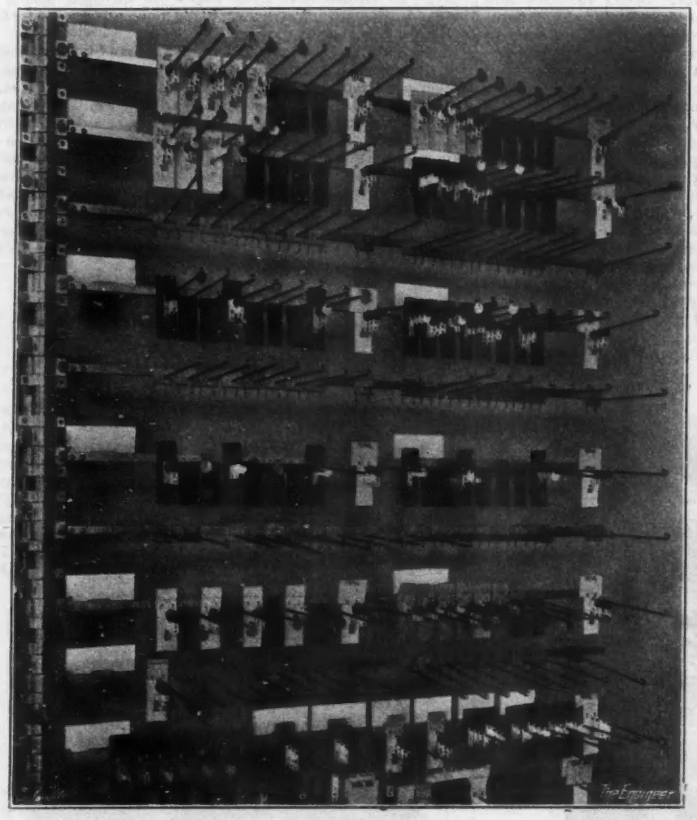
from time to time with many of the vehicles shown, but we illustrate herewith some new examples of containers, of which eleven examples designed for various purposes were on view. There are now no less than 10,636 containers on British railways, whereas in 1928 only 1574 were in use. In order to meet the various needs of different industries, a series of containers has been evolved. The "A" type, an example of which is illustrated in Fig. 1, is used for the conveyance of various commodities and has a capacity of 2½ tons. In order to meet the requirements of the building trade small containers with lids, designed to carry 1½ to 2½ tons of bricks, stone, or tiles, have been produced. The "B" type of container has a designed capacity of 4 tons and its dimensions are 14ft. long,

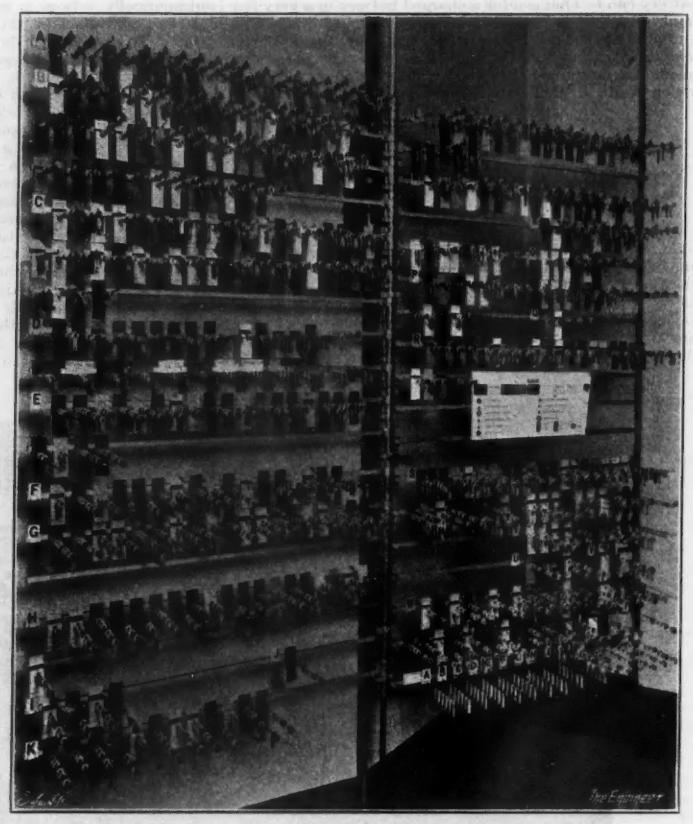
FIG. 2—"G" TYPE CONTAINER

6ft. 6in. wide, and 6ft. 8in. high. The "C" type has a 3-ton capacity, and the "D" type will take 4 tons. In Fig. 2 we show a "G" type container, which is used for the conveyance of grain in bulk, and has a capacity of 2½ tons. It is furnished with a special loading door and grain can be carried in it in perfect condition over long distances. An interesting example of container design is the special "AX," shown in Fig. 3, which is insulated with a 10in. thickness of cork to permit the transport of "Drikold," or solid carbon dioxide gas. The loading and unloading is carried out through a hatchway in the roof of the container. From among the four examples of covered wagons we have chosen for illustration the 20-ton bulk grain van, which is a steel vehicle, specially designed to allow the grain to be loaded into the top from a boat or barge and to

PROGRESS-OF-WORK INDICATORS

COLOURDEX (BRITISH SYSTEM), LTD., LONDON, ENGINEERS





discharge automatically into a hopper or on to a travelling belt.

The open wagons shown at Euston included examples of the latest 20-ton coal wagons with end and side doors or bottom doors. Larger vehicles included a 40-ton steel hopper wagon and a 50-ton brick wagon, designed to carry about 20,000 bricks.

British railways have recently given much consideration

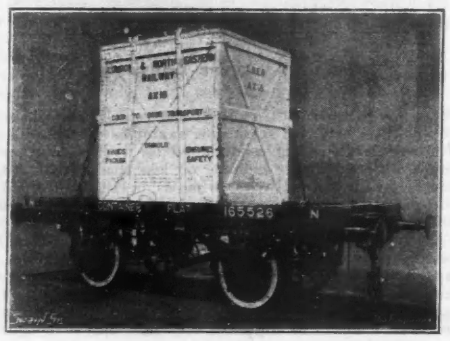


FIG. 3—CONTAINER FOR DRIKOLD

to equipment designed for the movement of heavy or large consignments, generally known as "exceptional freights." Among the vehicles put into service for this work there were exhibited a 65-ton bogie well trolley wagon for the conveyance of engines of any gauge for shipment abroad; a 20-ton well trolley wagon for excavators, steam rollers,

FIG. 4—20-TON BULK GRAIN VAN

traction engines, &c., capable of loading within 15in. from rail level; a 70-ton twin girder set to carry bridge girders 120ft. long and 11ft. high; a 120-ton side girder wagon for the carriage of electrical transformers; and 80-ton well glass wagon for large sheets of glass, shop window frames, huts and houses in sections, and the largest railway wagon in Great Britain, a 150-ton well trolley wagon which can carry heavy stators, turbine cylinder castings, large stern frames, ships' rudders, marine engines, ingots, anvil blocks, and concentrated weights up to 150 tons by the application of the cantilever principle, by which the weight of the load is spread over fifty-six wheels.

Progress-of-Work Indicators.

We recently inspected at the offices of Colourdex (British System), Ltd., Melbourne House, Aldwych, W.C.2, an installation of indicators for progress sales, work progress through factories, &c., a demonstration of which showed its adaptability to practically all branches of industry. The system employs a main tubular stand, 6ft. high, placed against a wall, from which radial swinging U-shaped metal arms, 3ft. long, project. There are usually forty arms on a stand, twenty on each side. Clips, from which project wires of varying lengths, are placed on the arms in groups which may vary as the type of goods, group of processes, individuals or machines may require. Indication is effected by small celluloid discs and tabs, which are easily clipped on the wires. Each wire may be subdivided into groups to represent periods of time, processes, parts, &c.

In the type of installation of most interest to engineers each arm could represent a particular machine being made, each group of clips representing a part of the machine, and the wire on each clip representing a separate part passing through the machining process. The time which should be taken by each process, such as cutting off or casting, turning, hardening, grinding, &c., is indicated by a numbered or lettered disc, and the date for finishing the operation on a tab As each process is finished to date its respective tab and disc are removed. Hence any delay in the shops is immediately noticed by the tab remaining on the wire. In these cases of delay a red "danger" tab is placed at the beginning of the wire and remains there until the lost time has been made up. At the back of each clip is fastened a small analysis book, in which particulars of previous work of a similar nature are briefly entered. When accepting orders a brief glance at the installation immediately shows the works manager the amount of work in the shops, the machines occupied, and when they will be free, and he can then arrange, with the minimum of trouble, the progress of the fresh work and estimate the delivery date without danger of overlooking work already in progress in the various departments.

The method of procedure in using the "Colourdex" system in one large industrial plant is as follows. The arms on one side of the stand represent unissued orders and on the other side they represent issued orders. Orders are divided into four types, each having its own coloured card giving details of the order at the back of the clip: yellow, for dispatch as soon as possible; grey, to have the order ready as soon as possible; green, part delivery by a certain date; and red, promised or urgent orders. The tabs hanging on the wires represent dates of delivery and quantities. The wires are arranged in groups of weeks or months each with its respective coloured tabs showing the state of work for that period, thus ensuring an even flow of work and avoiding overcrowding of machines or departments.

The great advantage of the method lies in its simplicity of operation, and the instantaneous availability of the information which it provides. We are informed that a number of large industrial plants have already been equipped. We illustrate herewith one section of a typical installation which has not yet been completely filled, and one of the complete sets which has been installed by the G.P.O. for use in connection with the erection of telephone exchanges throughout the country.

BESSEMER STEEL REVIVAL IN AMERICA.

That there are possibilities of development of the present operating practice in the manufacture of Bessemer steel, as well as of greater control of its ultimate quality, while its deficiencies are often over-emphasised, is the basis of a recent American discussion on the manufacture and properties of Bessemer steel. It is urged that any steel-making process which possesses the quality characteristics and operating flexibility that is embodied in the Bessemer steel mill deserves study and development. This is specially true since the progress made in improving the quality of Bessemer screw steel has shown what may be accomplished by the application of adequate metallurgical study. Another point in evidence is the indication of higher resistance to corrosion in low carbon copper-bearing Bessemer steel as compared with similar low carbon copper-bearing open-hearth steel. The argument is that Bessemer steel is a neglected subject; certain inferior physical quality is assumed for it, and there has been a lack of interest in technical development and commercial application. There is even an assumption that Bessemer steel survives mainly because of low cost. Nevertheless, such steel constitutes a large volume of the tonnage in daily use. An important property of such steel is its free machining qualities. It is claimed to be the easiest machining steel available, and this property has been a large economic factor in the production and low cost of a great variety of manufactured articles requiring a large amount of machine work. In ten years the annual production of Bessemer ingots has ranged from 1,500,000 tons to 7,000,000 tons, which is more than the combined production of acid open-hearth, electric, and crucible steel ingots. Yet much more is heard about the acid open-hearth and electric furnace processes. Further, Bessemer steel ingots far exceed the tonnage of alloy steel ingots. One advantage pointed out is the flexibility in making small tonnages of different grades of steel, as with a single converter three grades of steel may be made in an hour, an important advantage in the recent situation of demands for small tonnages and quick delivery.

In order to elucidate the causes of a number of failures due to the corrosion of lead in buildings, a study has been made by the Building Research Station of existing literature on lead corrosion and certain experimental work carried out. An account of this experimental work and that of other investigators is given in some detail in Building Research Technical Paper No. 8. The purpose of the bulletin is merely to express in summary form for the convenience of architects and builders the practical significance of the conclusions reached. The main conditions under which danger of lead corrosion is to be found are briefly stated, together with suggested methods of prevention.

Recent Developments in Electrical and General Engineering.*

By M. G. S. SWALLOW.

AN adequate survey of the development of the engineering industry in the North-East Coast area during the life of the Institution, even if we exclude shipbuilding and marine engineering, which have been dealt with by other speakers, would necessitate an exceedingly long paper, and trench unduly upon the time available at this meeting. I have therefore considered the matter from the point of view of electrical engineering and power supply only, and have endeavoured to sketch broadly the manner in which the development of this branch of our activities has affected and interacted on engineering generally.

This district was one of the first to use and develop our main national source of power by the early exploitation of its coalfields, the association of coal with Newcastle being so ancient as to have become proverbial. By a natural sequence, shipbuilding and the production of iron and steel became established industries at an early date. Here also modern rail transport had its inception, and a reminder of its origin in the form of a permanent exhibit of what may be termed "the grandfather of locomotives" may be seen at Darlington Station. You heard yesterday and to-day how early efforts in these branches of industry gradually led to the outstanding developments of modern times, developments in which the North-East Coast has always taken a prominent part. These industries occupy such an outstanding position and have in the past provided employment for such a large number of workers that in assessing the position of our district as an industrial centre we may occasionally overlook the fact that another industry and its application are to-day of even greater importance.

If we assume the definition of an engineer adopted by one of our sister institutes as axiomatic, then one of our principal functions, raised to a duty to society, is the abundant and cheap supply of power. The concentration of a large number of different industries within the relatively small North-East Coast area made it easy to establish centralised power supply and this circumstance, coupled with local ability and enterprise, enabled us to become pioneers in the development of the supply and distribution of electric power.

While the stationary and marine steam engine, the locomotive, and various forms of textile machinery were invented and mainly developed in this country, electrical engineering in its scientific foundation and technical application is entirely international, and the civilised world as a whole has taken part in the inventions and developments which have resulted in the greatly extended use and application of electric power. On an occasion like this, however, we may be justified in remembering the names of two men who worked on Tyneside, Swan and Parsons, who, one with the invention of the incandescent electric lamp and the other through the development of the first commercial steam turbine, gave a powerful impetus to the growth of one of our largest present-day industries, that of the generation of electrical power and the production of its *matériel*.

Electric light and the development of the electric motor created a demand for increased electric power, which no doubt could have been satisfied with the machinery then available, and even without the advances achieved in the design of the steam turbine, the use of the existing steam power producers would have continued. The reciprocating steam engine continued to be perfected and built in larger and larger units with improving efficiency, but it is improbable that it could ever have been economically justified to build such machinery in units of the size now common with steam turbines. Analysing the progressive increase in the sizes of generating plant units and the demand for electric power, it would certainly appear that it was only after the turbine developed into a reliable machine, economical in operation, relatively cheap to build and house, and to a certain degree unlimited in size, that it was possible to reduce the cost of electric power generation to a figure which made all other sources of power supply uneconomical.

In more ways than the generation and distribution of electricity over a large area has the supply company done pioneer work and with the Wallsend Union Gas Company shared the honour of being the first electric supply authority in Great Britain to supply three-phase current for industrial purposes, from the Neptune Bank Power Station at Wallsend, in 1901.

	1907.[1]		1930.[2]	
	H.p.	H.p. per wage earner.	H.p.	H.p. per wage earner.
Electric power ..	1,212,000	0·20	10,749,200	1·75
Steam and water power	7,545,300	1·29	6,552,400	1·06
Total power	8,757,500	1·49	17,301,600	2·81

[1] For Great Britain and Ireland.
[2] For Great Britain and Northern Ireland, exclusive of Irish Free State.

It will be seen from the above table that while in the twenty-three years' interval the power available has nearly doubled, 62 per cent. of the total power in 1930 was electric supply, as against 14 per cent. only in 1907. This table also shows the gradual mechanisation of industry and indirectly the increase in employment due to mass production.

The progress of electric power supply in Great Britain has been most marked during the post-war years. In 1918 there were 421 power stations developing 4674 million units at a cost of 7¼ million tons of coal. In 1934 470 stations developed 16,140 million units using 11½ million tons of coal. Three and a-half times as much power was generated with only a little more than 1½ times as much fuel. In 1918 the best station used 2·4 lb. of coal per kWh, corresponding to a thermal efficiency of 12·4 per cent., whilst in 1934 the best figures were just over 1 lb. of coal per kWh, equal to a thermal efficiency of just under 28 per cent. In the last ten years alone the units sold per head of population per annum had increased from 88 to 226 and the electrical power available per head of population is to-day greater than it was in 1907 per head of wage earner alone.

The increase has been so rapid that fears might be expressed that we are reaching the saturation point and approaching a time when little new generating plant will be required, except to replace obsolete machinery. That we are a long way from such a position is evident if it is realised that in some countries, neither densely populated nor highly industrialised, the units sold per head of population per annum is between 800 and 1200. It would therefore appear that we have a long way to go before we reach a state of stagnation in this branch of industry.

It can be truly said that the old Newcastle-on-Tyne Electric Supply Company, with its sister companies, to-day known as the North-Eastern Electric Supply Company, was the prototype of the present interlinked electric supply system of the country, and the pioneering work and imaginative conception of our supply company, advised by their able and enthusiastic consulting engineers, placed us much earlier in a favourable position as regards an abundant supply of cheap electric power. It is not surprising, therefore, that the increase in the supply and utilisation in the country as a whole during the last ten years has been much more rapid than on the North-East Coast, and these facts, together with those of the depression and migration of industry, should be borne in mind in considering the following interesting figures, which show the growth of the electrical power supply industry in the North-East Coast area over the period 1914–1934, the particulars for 1914 necessarily being approximate only :—

	1914.		1934.
1. Extent of territory (including areas in common with other electrical undertakings) square miles	650	..	5,640
2. Population of area :			
(*a*) Total	1,200,000	..	2,600,000
(*b*) Industrial (estimated) ..	1,000,000	..	2,000,000
3. Mileage of low-voltage distribution mains	366	..	1,350
4. Generating plant installed, kW	91,460	..	499,750
5. Units sold (including bulk supplies to other electrical undertakings)	263,513,897	..	730,287,647
6. Coal consumption in lb. per unit sent out	2·516	..	1·607
7. Units sold per head of population	219	..	281

It is difficult to ascertain the amount of power which was available per wage earner fifty years ago, as no reliable statistics are available, but in more recent times the figures of the census of production for the years 1907 and 1930 show the gradual change over in the source of power supply and the increasing availability of power per wage earner.

As a typical example of the manner in which developments in one branch of industry may react upon another it may be mentioned that, at the time when the Cunard Company were contemplating the construction of the "Mauretania," the Neptune Bank Power Station contained a 3000 h.p. turbine (the largest then running in Great Britain) and the Engineering Committee appointed to consider the method of propulsion for the vessel which was to establish records on the Atlantic visited the power station and studied the results which had been obtained there, before arriving at their conclusions.

The various power companies, the municipalities, and the manufacturing industries created the demand for large, cheaper and more economical machinery, improved methods of generation, transmission and transformation of electric power, and the industries concerned have always been able, not only to supply the demand, but to maintain a permanently rising rate of improvement. After 1900 the development of the steam turbine was mainly in the direction of large and more economical units, followed by the employment first of improved exhaust conditions by a proper study and correct design of condensing plant, work mainly carried out by D. B. Morison and Parsons, then as a further step the use of increased steam temperatures and pressures and modifications in the heat cycle by regenerative feed heating and reheating. The alternator kept step with the turbine development in size, thanks to the invention of the non-salient rotor by Charles Brown, and with the size the generation voltage increased also, so that to-day direct generation at 36,000 volts is common and even higher generation voltages are in prospect. Twenty years ago, turbine units of 5000 kW at 3000 r.p.m. and 15,000 kW at 1500 r.p.m. were the upper standard. To-day, the 3000 r.p.m. machine can be built for 50,000 kW and the 1500 r.p.m. machine for 100,000 kW or more. At the same time, the first cost of generating plant has decreased both relatively and absolutely, thanks to improvements in design, material, and methods of manufacture. In 1914 the cost of a complete 5000-kW, 3000 r.p.m. unit worked out at £4·2 per kW. In 1934 the cost of a similar unit was £3·0 per kW and of a 50,000-kW, 3000 r.p.m. unit £2·2 per kW.

Such large units constitute a concentration of tremendous energy in a relatively small space and requiring to be handled by switchgear of an altogether different type from that formerly in use. Here again the North-East Coast has led by the development of the enclosed type of switchgear, which has formed the prototype of switchgear the world over. Valuable research work is continually in progress with the object of improving the performance of control apparatus in order to render large power supply systems less vulnerable to fault conditions.

The early experience of the North-Eastern Electric Supply Company in long-distance power transmission, first at 3000 and 6000 volts, then rising to 11,000, 20,000, 66,000, and now 132,000 volts, in a district particularly exposed to high winds and salt-laden atmosphere, has largely served as the fundamental basis for the design of high-tension transmission work for this country, while the first protective system for the generating plant and transmission lines was devised in this city.

In all this work new engineering problems were continually occurring, leading to a new technique both in design and material. The high speed of the moving parts of the steam turbine and alternators, with the resulting increased stresses, called for new theoretical and experimental studies, which both the engineer and the metallurgist had to share. When turbines were first built the stresses in rotating discs could not be calculated, the knowledge of balancing and of the critical speed of bodies rotating at high speed was most elementary. New phenomena like the fluttering of turbine discs or the growth of cast iron at high temperatures, creep of steel under stress at high temperatures, erosion and corrosion of blades, all had to be studied as novel phenomena and solutions for their elimination or suitable methods of providing for them to be discovered. For solutions it was necessary to turn to the metallurgist and the chemist as well as the mathematician. Particularly when steam pressures and temperatures were raised in order to obtain better economy and smaller size plant for increased capacity, the boilermaker, the turbine and alternator maker had to turn to the metallurgist for assistance.

Concurrently with this development, progress had been made with the internal combustion engine and the metallurgist had already been faced with the problem of supplying material which had to meet similar temperature and stress conditions. Fortunately, the knowledge, particularly of heat-resisting alloy steels, is actually much older than the industrial demand in this particular field. The collaboration of the metallurgist and engineer has now resulted in the possibility of being able to obtain and use steel capable of permanently withstanding temperatures of 1000 deg. Fah., such as occur in gas turbines driving supercharging blowers and compressors, with sufficient mechanical strength to allow of their use in turbines of large diameters where the blade tip velocity may exceed 1000ft. per second.

In the design of electrical machinery similar problems in the supply of new materials had to be solved and more onerous standards of quality in existing materials set up. Laboratory experiments as well as large-scale research and working experience have led to improvements in such materials as the steel sheets used for the laminated structure of electrical machinery, where the progress attained is shown by the fact that the loss per pound of dynamo steel sheets has been reduced from 2 watts thirty years ago to 0·75 watt to-day. Equally far-reaching improvements have been made in insulating material through better grading and marketing of mica, in the methods of weaving cotton and asbestos fabrics, production of special papers, increased knowledge and skill in production of varnishes, the discovery and development of synthetic resin, and moulded insulation material, as well as in ceramics.

On the production side, a revolution is even now taking place through the extended application of fusion welding, which affects equally design and manufacturing methods. To-day, parts of simple shape, such as stator frames for alternators and motors, bed-plates, tanks, &c., are usually fabricated from fusion-welded steel plates. The same method is already being applied in heavy structures, such as the frames of large machine tools, Diesel engines, locomotives, railway coaches and wagons, and certain modern designs of boilers only become constructively possible by the application of welding in place of riveting. The method is also successfully applied to turbine rotors, in which disc forgings forming a drum rotor have to be assembled, as the jointing of the parts by electric welding is a safer and more reliable method than shrinkage, giving, in addition, better utilisation of material and reduction in weight. The manufacture of complete turbine and compressor cylinders by the same method, at least for smaller gas turbines and centrifugal blowers, has now been standardised. There are indications that foundry work, both in iron and steel, will in the future be restricted to those parts which are either too complicated to fabricate or where repetition work for mass production justifies expensive patterns and the use of moulding machinery.

This recital of the factors that have made possible the development in this single branch of engineering could be repeated for all branches. In the building of locomotives, internal combustion engines, machine tools, textile machinery, electrical power plant, or other engineering productions, the invention of a new type, the re-designing of a detail, the perfecting of a new process or the demand to meet more onerous operating conditions, call forth not only the inventive and constructive abilities of the specialist in that particular branch, but also the collaboration of the chemist, the metallurgist, the geologist, and in some cases even that of the agriculturist; so that progress in engineering demands correlation of many branches of science and technology. The greater the advances the more must the engineer depend upon patient research in the laboratories if he is to deal honestly and truthfully with his materials, and the more exacting operating conditons become and the wider the mechanisation of modern civilisation, the more must the engineer, while specialising in his own branch, keep his eye on the progress being made in other directions and apply knowledge gained in other fields to his own problems.

It would appear that those of us who have some knowledge of the history of engineering should appreciate and encourage by every available means all systematic co-ordinated and co-operative research, not only for the commercial benefit of the individual branch or firm, but for industry as a whole, and when such research work reaches fruition it is of no use if it is allowed to lie unused in the records of the National Physical Laboratory, transactions of learned societies, or the pages of scientific papers, allowing each manufacturing firm only the use of the results of their own experiments and those of their own particular research association. The industrialist should aim at a far wider understanding of work carried out in the past and of what is being done at present through proper collection and distribution of such knowledge. When this is done there still remain the advances of new work in the fields of pure and applied science, which may in many cases find engineering application. In order that the best possible use may be made of new and past knowledge in fields which would appear in some cases to have only a remote connection with engineering, we should train our young engineers to be, not only specialised in their particular field, but also equipped with a wide scientific grounding, so that later, when at work in industry, their understanding of advances in other fields may enable them to apply new ideas and new methods to old problems.

* North-East Coast Institution of Engineers and Shipbuilders, July 18th, 1935.

For us on the North-East Coast this is of the greatest importance, as we have always been more concerned with the manufacture of specialised machinery than with mass fabrication. Such specialised machinery is neither of fixed design nor permanent type. In some cases it is already obsolete before it has aged, so that the very nature of our industries demands the continual striving after something newer and better.

It is only thus that we can maintain our position. What we have done in the past is and can be imitated, and the modern imitator, particularly in the East, will, with his cheap labour, always be able to undersell and take our markets from us. To maintain our position of a highly industrialised district we have to follow new paths and must be prepared to adopt new conceptions. There are signs of the gradual development amongst us of a broader view of the function and sociological influence of the engineer. Regarding it as an elementary duty to produce the maximum effect with the minimum of effort, abhorring waste either of material or labour and conscious of the magnitude of the results already achieved and the as yet undeveloped potentialities available to society through the medium of our services, we are beginning to wonder at times as to the precise nature of the obstacles which prevent these achievements and potentialities from being more rapidly translated into greater prosperity and general happiness. While continuing our efforts to produce the best technically, therefore, we are beginning to perceive that we must embrace what may be termed in engineering language the "maximum intrinsic, unconditional, and universal availability of the product" among the aims to be kept before us and earnestly striven for, if necessary, but activities outside what has been hitherto considered the technical field.

The history of our Institution is a record of men who have led and achieved in the past and who have helped to make our district great. To-day, the inventive ability, the scientific knowledge, the tenacity and skill which have made us successful are still ours. Some of our industries may decline temporarily or may be lost to us. But this is no reason for despair or lament. Engineering is not only progressive, but is for ever conquering new fields and our activities spread and continually increase. With the initiative, imagination, and energy the North-East Coast has always applied, with our advantages of climate, power, and raw material, with the skill and adaptability of our workers, the fortune of our future is assured.

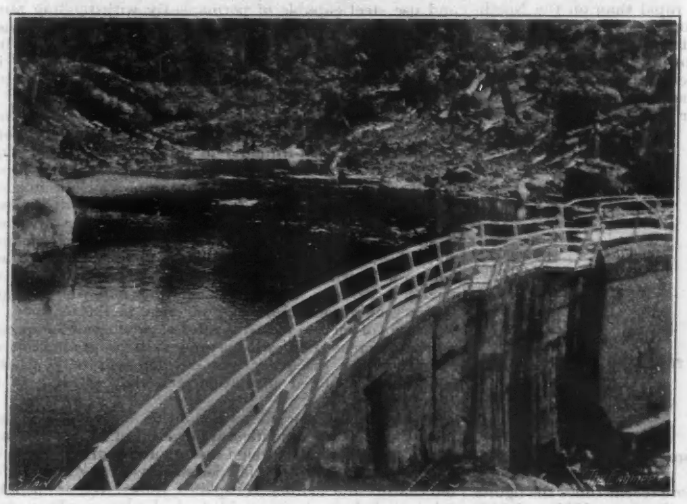


FIG. 1—VIEW OF DAM SHOWING SYPHON SPILLWAY

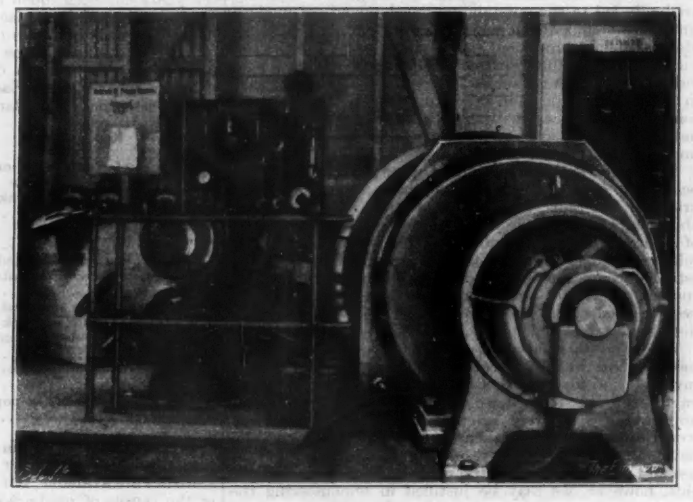


FIG. 2—GENERATING EQUIPMENT

New Hydro-Electric Station at Brooklyn, New Zealand.

THE new hydro-electric scheme of the Waimea Electric Power Board at Brooklyn, Nelson Province, possesses several very interesting features. The district served by the Board comprises Motueka, Riwaka, Tasman, Kapua, and Moutere. In the development of the scheme it was found that the most economic plan was the combination of a hydro-electric and an oil engine plant, the former to supply the base load and the latter to act as an auxiliary in the event of water shortage and as a peak reducer.

There are two generating stations, Brooklyn hydro-electric station and the old Motueka Borough power station. In regard to the first, a dam 20ft. high has been built across the valley of the Brooklyn stream at a point 11 miles from Motueka, where the stream runs through a narrow gorge. The dam provides daily storage for the water and not for producing head, as the dam site is 920ft. higher than the power-house site. The dam is of the arch type, not assisted by gravity, and is rather unusual by reason of its light and bold design. As access and transport of materials were difficult and every cubic yard of concrete was important, the dam was designed as lightly as possible consistent with due safety, and is only 12in. thick for 12ft. down from the top, with a top length of 130ft. and a radius of 94ft. It is illustrated in Fig. 1. A scour gate is provided at the bottom of the dam, so that the pond may be scoured out from time to time, thus preserving the storage capacity. The dam is fitted with a syphon spillway for flood discharge. The normal flow of the stream is from 3 to 5 cusecs, but occasional high floods may reach 500 or 600 cusecs. Owing to the topography of the gorge, and the design of the dam, to discharge this quantity of water by the usual type of spillway would have been expensive, and a syphon spillway—the first one of the kind installed in New Zealand—was incorporated in the dam. It acts as an ordinary weir first, but when the discharge has reached a certain value, the air is gradually entrapped and exhausted from the downstream leg, and the weir finally runs as a full syphon. When the water level in the pond falls to its normal level, the syphonic action is broken by means of air vents. The water is led from the dam to the power-house through a pipe line, 73 chains long. The first 31 chains follow the contours of the valley with a slight fall, and from the surge tank at 31 chains the pipe line goes down a steep spur to the station, the fall being 920ft. in 42 chains. The pipes are welded copper-bearing steel pipes with flexible joints, 14in. in diameter from 0 chains to 51 chains, and 12in. diameter from 51 chains to the power-house. The thickness varies from $\frac{1}{4}$in. to $\frac{1}{2}$in., as the pressure increases. Concrete anchor blocks take the thrusts at angle points, and the pipe is buried to a depth of 2ft. Air valves are fitted to prevent collapse in case of a burst pipe.

The generating plant consists of a Boving pelton wheel, 375 h.p., 1000 r.p.m., single-jet machine, with oil pressure governor, actuating a deflector and needle valve, which is direct coupled to a Metropolitan-Vickers generator, 400 volts, 312·5 kVA, at 0·8 power factor. The plant is equipped with safety devices to shut it down in case of hot bearings, governor failure or overspeed. It is illustraded in Fig. 2. The main switchboard, also manufactured by the Metropolitan-Vickers Electrical Company, Ltd., includes the usual meters, synchronising gear, overload, low voltage, high voltage, and earth leakage protection gear, and also a wattmeter transmitter, which is described more fully below. The current is stepped up to 11,000 V at the power station and transmitted over a 7/·064 copper line to Motueka.

In what was formerly the Motueka Borough power-house there has been installed a 165 h.p., six-cylinder, 750 r.p.m. Davey Paxman C.I. engine, direct coupled to an English Electric generator, 125 kVA, 3300 volts. In addition to its functions as a standby and peak reducer, this set may be required for auxiliary service, because, although the normal flow in the Brooklyn is from 3 to 5 cusecs, it occasionally falls in dry spells to a value considerably lower. The installation of the set also enabled supply to be begun to the borough and Tasman areas some months earlier than would otherwise have been possible. The existing 40-kW suction gas plant has been partly dismantled, the generator now being used as a synchronous condenser for improving the power factor, in addition to which the gas engine fly-wheel is of pronounced effect in assisting the governing of the system frequency.

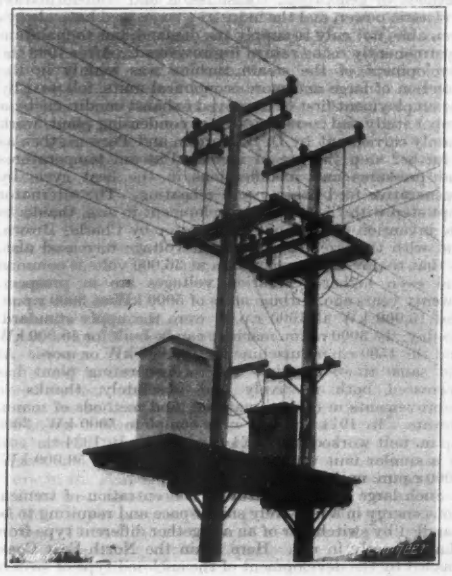


FIG. 3—TWO-POLE SUB-STATION

Remote indicating equipment has been installed, by which at any time readings can be obtained in Motueka power-house of (1) the stream flow in cusecs; (2) the water level in the pond at the dam; and (3) the load in kilowatts at the hydro station. The transmitting element in each case is a Midworth distant repeater, worked in the case of (1) by a float registering the head over a V notch, in the case of (2) by a float at the dam, and in the case of (3) by a wattmeter. By a system of selective relays and rectifiers, all of these signals are sent over a single pair of wires, which is also used for the high-tension telephone between the two power-houses. At the weir station a recorder has also been installed, with a weekly chart, which will be changed when the engineer makes his weekly visit to the headworks.

The reticulation of the district is standard 11,000/400/230 volts, and will supply approximately 800 consumers. The more heavily loaded lines are carried on reinforced concrete poles, and the lighter lines on railway rails. In the concrete poles, high strength steel has been used, making the poles very light in proportion to their strength. A two-pole substation in course of construction is illustrated in Fig. 3.

A point arose in the lay-out of lines through the Tasman area. This area is almost entirely covered by orchards, and it was found that the best lay-out involved running the 11,000-volt lines through orchards and over the fruit trees. Spraying at very high pressures, up to 450 lb., is in vogue in this district, and with solutions of metallic salts used for spraying, the question was raised whether there would be danger to the orchardists from the 11,000-volt current finding a conducting path through the drops of spray. A series of experiments was therefore conducted by the Board and the results obtained were confirmed by tests made by the North Canterbury Power Board. In the first case a three-phase 11,000/400-volt distribution transformer was connected step-up, into one phase of the 11,000 V-sided grounded and the other two phases strung 18in. apart and 6in. above the gun. Voltmeters were connected between the spray gun and the grounded leg. A strong solution of copper sulphate was sprayed over the wires, but no indication was obtained on a 250-V, 50-V, and finally a 5-V voltmeter, nor was there any sign of flashover between the 11-kV wires. At North Canterbury various mixtures were sprayed over a three-phase, 11-kV feeder, the nozzle being adjusted so that the jet reached 2ft. above the wires before it completely broke. No indication was obtained on a 35-V voltmeter connected between the brass spray gun and the earth, and before the test was concluded the gun was actually handled by the inspector with bare hands.

In actual practice the high-tension lines are run on 36ft. rails, the conductors being 26ft. above the ground.

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Motorshipping. By A. C. Hardy. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 7s. 6d. net.

Meter Engineering. By J. L. Ferns, B.Sc. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, W.C.2. Price 10s. 6d. net.

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Chimneys and Flues: Domestic and Industrial. By P. L. Marks. London: The Technical Press, Ltd., 5, Ave Maria-lane, E.C.4. Price 4s. net.

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Machines and Men: An Autobiography of an Itinerant Mechanic. By W. F. Watson. London: Geo. Allen and Unwin, Ltd., 40, Museum-street, W.C.1. Price 5s. net.

A Comprehensive Treatise on Inorganic and Theoretical Chemistry. Vol. XIV. By J. W. Mellor, D.Sc., F.R.S. London: Longmans, Green and Co., Ltd., 34, Paternoster-row, E.C.4. Price 63s. net.

The British Engineers' Association Classified Handbook of Members and their Manufactures, 1935. London: The British Engineers' Association, 32, Victoria-street, S.W.1. Issued free of charge to machinery buyers.

An Introduction to the Study of Physical Metallurgy. Third edition. By the late Dr. Walter Rosenhain, B.A., F.R.S., and Dr. J. L. Haughton. London: Constable and Co., Ltd., 11, Henrietta-street, W.C.2. Price 20s. net.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Steel Agreement.

After protracted negotiations between the International Steel Cartel and representatives of the British Iron and Steel Federation an agreement has been reached, and the British steel industry has entered the European Steel Cartel for the first time. The full Steel Cartel has been reconstituted for five years, but is terminable after three years, subject to agreed notice. The quota of imports of steel into Great Britain for the year beginning August 8th will be 670,000 tons, instead of 643,000 tons, as fixed under the provisional agreement, whilst for the four years beginning August 8th, 1936, the annual quota is to be 525,000 tons. Exports are to begin at once, and any profit from reduction of duty will revert to the seller. A very difficult point to settle was the formation of a sales organisation in Great Britain to deal with Continental steel exports to this country, the proposal to establish a sales organisation here meeting with considerable opposition from Continental steel makers, but eventually the following agreements were reached :—(1) Prolongation for four months (August 8th to December 8th) of the provisional period of application of the Anglo-Continental Convention, pending the setting up of a British central bureau of control in London ; (2) the immediate resumption of sales with Great Britain on the basis of the old prices and a Customs duty of 33⅓ per cent., it being understood that the profit resulting from reduction of the import duties will be credited later to the vendors. Agreement was also reached with the Polish steel masters. In addition to the Steel Cartel agreement, there was a renewal of the European Rails Cartel for a period of six years. The Rail Cartel is now composed of the following member countries :—France, Belgium, Luxembourg, Germany, Austria, Hungary, Czechoslovakia, Poland, Great Britain, and a group of American producers.

Pig Iron.

A considerable amount of interest has been displayed in the pig iron position, as a result of the recent advance in the rates for East Coast hematite, which denotes a further step in the elimination of competition among hematite producers, and the co-ordination of prices throughout this country. The revision of prices for East Coast hematite has now been completed, and the general principle adopted is that in each of the producing areas the local delivered price of No. 1 hematite shall be 71s. per ton, and the schedule prices for other areas will be arrived at by adding delivery charges to consumers' works. Two additional hematite furnaces were blown in at Middlesbrough last week and there are now nine blast-furnaces producing hematite on the East Coast. Producers of Cleveland foundry iron are exceptionally well sold ahead, and with continued heavy deliveries there has been further talk of bringing one or more blast-furnaces into operation at a very early date. The demand from the light castings branch has shown signs of expansion, and there is every indication of a larger volume of specifications, both from Scotland and the Midlands. The uncertainty with regard to future prices has led to increased activity in the Midland pig iron trade, and some contracts are said to have been made which cover deliveries until the end of the first quarter of next year at current rates. There were also fairly substantial orders for forge iron. No decision has yet been arrived at by the Central Pig Iron Producers' Association with regard to a revision of prices. Business is proceeding on the old basis, though furnacemen limit transactions, except in special cases, to sales for prompt delivery. During the recent buying movement substantial security has been taken by consumers against requirements up to midsummer, 1936. According to reports from Birmingham, there has been an unexpected development with regard to the prices for West Coast hematite, it being understood that the recent advance has been rescinded and the price is therefore back on the old basis. In North Lancashire and Cumberland there was a satisfactory business in hematite pig iron, and apparently makers are well booked for a long time ahead, and they are much encouraged by this increased volume of forward business. In the West of Scotland there was a revival of activity following the holiday, with a better inquiry for No. 3 foundry iron. At the Falkirk foundries work has been generally resumed, and they are taking steady deliveries from their orders placed for running contracts to the end of the year.

The Midlands and South Wales.

Conditions in the Midlands remain fairly satisfactory, though there has been rather a lull from the recent fillip in the demand for iron, steel, and allied products. No decision has yet been arrived at regarding a revision of pig iron prices. Meanwhile, a limited business goes on at the old rates. As regards semis, most of the re-rollers in this area are largely covered at current rates and only a few transactions were reported during the past week. It is understood that in one or two instances deliveries of soft steel billets are in arrears, though this is considered to be only a temporary phase. Sheet bars had a moderate inquiry and a better volume of orders would give satisfaction. So far, quotations for Continental semis for the last quarter of the year have not been forthcoming. For finished iron the position shows little change, there being a sustained demand for common bars with a steady business reported in marked bars, and it is good to be able to report a slight improvement in the inquiry for crown bars. There has been no competition from foreign iron in this district. The works engaged on rolling joists and sections are well engaged, and in some cases they are provided with sufficient orders to keep them busy for some time ahead. The principal demand is for heavy steel sections and joists, as light sections are selling only in moderate tonnages. The trade in heavy plates has been inclined to drag. There was a regular demand for steel strip and hoops, although the motor car and cycle trades are not such active buyers of special grades owing to the season's ebb. The call for small steel bars has been well maintained, and in the absence of supplies of Continental steel re-rollers are in a much improved position ; in fact, they are better employed than usual at this time of the year. However, supplies from the Continent are expected from August, and if the prices are sufficiently attractive they will no doubt receive a certain amount of support from this side. Prices for the home product remain unaltered. While makers of soft billets are kept busy on orders placed in advance, current transactions represent only small tonnages. Sheet makers reported a good business in black sheets and a poor inquiry for galvanised descriptions. Manufacturers in South Wales are generally well booked and a fairly confident feeling continues to prevail. The export demand for heavy steel products has quietened down to some extent, but there is no abatement in the home trade owing to the call for steady tonnages of structural and railway steel. The market for semis was a trifle less active, as consumers appear to be able to carry on with their present level of deliveries. Fresh orders for tin-plates were of moderate volume, but most of the works are well sold forward and most of them are operating at rather more than half capacity. A most encouraging feature in connection with this industry is the continued good demand on home account. For sheet and tin-plate bars there was a steady demand at fully recent rates.

The North-East Coast and Yorkshire.

There has been no falling off in the demand for pig iron and producers of Cleveland have no difficulty in making a quick clearance of the whole of their output. In view of the possibility of an early advance in prices, consumers have displayed more haste in covering, not only immediate but potential requirements. The recent rise in the rates for East Coast hematite has failed to check the demand. Exports of manufactured iron and steel from the Tees during the present month have shown a steady increase, with substantial tonnages despatched to South Africa. A quiet business was reported in semis, as most consumers have covered their requirements within a reasonable period. The recent contracts placed on the Tyne, Wear, and Tees will eventually bring real benefit to steel producers. In the Sheffield area the production of steel was actively proceeded with, and there is every indication that the output for the last half of the year will be equal to, if not better than, that of the first six months. Values of all descriptions of steel were firmly upheld. There was an active demand for basic billets, and the improvement noted in acid billets a week ago has made further progress. Steel strip was an active feature, and a substantial business was reported in wire rods. Special steels attracted good attention and there was a very heavy demand for stainless steel sheets. A feature of interest during recent weeks has been a valuable business in aircraft steels. The forward movement in aircraft construction has resulted in a large number of orders being placed in this district. The heavy forges are well engaged on large hollow forgings. The order obtained for the machinery of the seven vessels to be built by the Furness Shipbuilding Company for Russia is a substantial addition to the work which the North-Eastern Marine Engineering Company, Wallsend, has in hand, and this firm is probably one of the busiest in the country at the moment. The Tyneside Industrial Development Board has, during the past week, received five inquiries for industrial sites. It is reported that ship-breaking has begun at Messrs. Palmer's yard at Jarrow. A large amount of ship-repairing work is in progress on the Wear.

Scotland and the North.

Following the holidays in Scotland, most of the works have now re-opened and in some cases there was a fair accumulation of fresh orders. There was a moderate inquiry for locally produced pig iron and most of the foundries are taking good deliveries. The steel works have fairly good order books with which to begin operations. The orders comprise specifications for ship plates and sections, but there is still abundant room for a further accession of fresh business. The engineering branch, boilermakers, and producers of rolling stock are all busily engaged and moderate activity is expected to prevail until the close of the year. The outlook generally is much more promising than was the case a year ago. The demand for bar iron shows definite improvement and steel re-rollers are better employed than for some time past. Black sheets were a good feature, particularly as regards heavy gauges, but the export call for light gauges was disappointing. There was no improvement in the export demand for galvanised corrugateds. Following the recent audit of average selling prices, wages in the Scottish heavy steel industry will be advanced 5 per cent. on the basic scale. The increase takes effect as from August 1st and about 5000 men are affected. The actual increase, based on present rates, is about 4 per cent. On the North-West Coast there has been more willingness to place orders for forward delivery, and in spite of the recent advance in the rates quoted for hematite pig iron, a steady business continues to be done. Considerable tonnages of common iron have been sold during the past week and some makers have orders covering deliveries for a few months ahead, whilst other producers appear reluctant to proceed far at current rates. The holidays checked progress to some extent, but the call from the light castings branch opened briskly, while in other directions the outlook is considered to be very favourable. In the bar iron trade there is a keen inquiry for No. 3 and No. 4 grades at very firm prices. Moderate orders were placed for structural steel, as large quantities continue to be used in the Manchester area. In the Workington district there was a steady volume of orders for steel rails, billets, and bars. Variable conditions prevail among textile machinery manufacturers, though here and there a decided improvement was reported. Machine tool makers have a fair amount of work in hand and some general engineers are calling for larger quantities of iron and steel material. The market for iron and steel scrap remains steady and good quantities of the latter are going into consumption. Producers of boiler and tank plates are moderately engaged, but an early improvement in the volume of fresh orders would be generally welcomed.

Current Business.

Recent business includes an order for a steamer of 7800 tons deadweight, which has been placed with Short Bros., Ltd., of Sunderland, by S. G. Embiricos, Ltd., of Athens and London. The machinery will be supplied by the North-Eastern Marine Engineering Company, Ltd., of Wallsend. Following recent announcements of extensive additions, alterations, and improvements to mill equipment at their Cleveland works, the board of Dorman, Long and Co., Ltd., has decided to install a cold rolling mill and plant for the production of cold sheet and strip up to 72in. in width, also at their Cleveland works. This decision is a natural development of the policy of the board to operate plant at present idle and therefore immediately available for the preliminary processes necessary for more highly finished steel products not manufactured in this country, for which there is a very considerable demand. It is the intention of the Mond Nickel Company to expend nearly £150,000 on extending its works at Clydach, near Swansea. The ultimate object of the company is to double its refining capacity in Wales and so keep the works in step with the other refineries owned in Canada by the parent company, the International Nickel Company of Canada. About a year ago the Mond Company abandoned the manufacture of copper sulphate at Clydach, but in consequence of the improved demand for nickel nearly all the men displaced have been re-engaged. The company has decided to extend the Clydach works because of the general improvement in the automobile, aeronautic, and general engineering trades. According to a report from Pittsburgh, the plant of Gears and Forgings, Inc., Ford City, Pennsylvania, has been purchased by Thomas W. Ward, Ltd., of Sheffield, England. The price paid was 81,276 dollars. There was no opposition to the sale, either by creditors or stockholders. The purchase includes the plant, machinery, and equipment, working drawings, and manufacturing rights. In face of keen Continental competition the Stanton Ironworks Company, Ltd., Nottingham, has received an order for large-diameter spun iron pipes to the value of over £50,000 from the municipality of Skoplje, Yugo-Slavia. Stoke Newington Borough Council is placing a contract with Foster and Dickson, Ltd., London, for the £78,367 town hall extension scheme. The London County Council has under consideration an estimate of £818,500 for the construction of the first part of the proposed County Hall extension.

Copper and Tin.

Conditions on the standard copper market have been somewhat easier during the past week, due in part to a quieter demand, but there was considerable resistance to the downward movement. It is reported that consumption in this country and on the Continent has been fairly active, and in the United States the recent improvement in the domestic demand has shown no falling off. Following the recent meeting of producers in London, there still appeared to be some nervousness as to whether American producers would honour their agreement with regard to the quantity to be exported, and in some quarters there was uncertainty as to the maximum tonnage to be shipped in any one month. It is understood, however, that shipments will definitely not exceed 8000 tons per month. In New York the price for electrolytic, prompt, closed at 7·67½ c., c.i.f. Europe. . . . After the excitement last week, price movements in tin were somewhat erratic, but became steadier towards the close. Complaints of the present situation are becoming more general and there is severe criticism of those in control of supplies. The demand for tin in this country continues satisfactory and there was moderate buying by the Continent. In view of the restriction in supplies, the Buffer Stock Committee has decided to ship 1200 tons of the "buffer" stocks from the United States to this country. It is understood that the International Tin Committee will meet shortly to consider an increase in the output quota. The July *Bulletin* of the International Tin Research and Development Council at The Hague shows world production of tin in the first five months of 1935 as 45,089 tons, an increase of 3032 tons on the corresponding period of 1934.

Lead and Spelter.

Lead prices have reacted from last week's high levels and there was a sharp momentary fall to £14 12s. 6d. for October. The setback was not unexpected in view of the recent substantial advance and the position remains sound. Consumption throughout this country is being maintained at a high rate and supplies are being readily taken up. The Continent continues to be a liberal purchaser and the position in the United States is considered favourable. The American figures issued for June are not particularly good, as they show an increase in stocks of about 6000 short tons, in spite of a reduction in output of slightly over 4000 tons. Stocks of refined lead at the end of June totalled 231,100 tons, compared with 225,100 tons at the end of May. Production during the month totalled 33,000 tons, against 37,400 tons, whilst shipments amounted to 27,000 tons, compared with 32,300 tons during May. . . . Spelter values have moved more or less in unison with those of lead. The demand in this country has been moderately active and consumers on the Continent have bought a fair amount. The market generally maintained a steady undertone. There has been further talk of a revival of the International Zinc Cartel, but no definite news is forthcoming.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. Coast—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 10 6	3 2 0
No. 1	3 11 0	3 3 6
Cleveland—	(*D/d Teesside Area*)	
No. 1	3 10 0	3 4 0
No. 3 G.M.B.	3 7 6	3 1 6
No. 4 Forge	3 6 6	3 0 6
Basic (*Less 5/– rebate*)	3 10 0	—
Midlands—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic (*Less 5/– rebate*)	3 15 0	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 11 0	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d (*Less 5/– rebate*)	3 10 0	—
N.W. Coast—		
Hematite Mixed Nos.	3 14 0 d/d Glasgow 3 18 6 „ Sheffield 4 4 6 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
Lancs.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. Yorks.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
Midlands—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
No. 3 quality	7 10 0	—
No. 4 „	8 0 0	—
Scotland—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. Coast—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

	Home.	Export.
London and the South—	£ s. d.	£ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 6	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¼in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 10 0	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Plates, ¼in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 5 0	8 5 0
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 10 0	8 5 0
Boiler Plates, ¼in.	9 7 6	7 15 0 to 8 5 –

STEEL (*continued*).

	Home.	Export.
Glasgow and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates	9 5 0	8 5 0
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 0
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 10 0	8 5 0

Ireland—	Belfast.	Rest of Ireland.
	£ s. d.	£ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G. to 13-G., f.o.r.	9 10 0	8 15 0
14-G. to 20-G., d/d	10 15 0	9 0 0
21-G. to 24-G., d/d	11 0 0	9 5 0
25-G. to 27-G., d/d	11 12 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanized Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 0 0
2-ton to 4-ton lots	13 7 6
Under 2 tons	15 0 0

Export: £12 15s. 0d., c.i.f. India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18/2.
Tin-plate Bars, d/d South Wales Works, £5 5s. 0d.

Billets—	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 to 250 tons	5 17 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 0 0	7/–
„ „ 8 p.c. to 10 p.c.	£21 0 0	7/–
„ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 0 0	11/–
„ „ „ 1 p.c. carbon	£36 5 0	11/–
„ „ „ 0·70 p.c. carbon	£37 5 0	12/–
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/6 per lb	

NON-FERROUS METALS.

Official Prices, July 31st.

Copper—		
Cash	£31 8 9 to £31 11 3	
Three months	£31 17 6 to £32 0 0	
Electrolytic	£34 15 0 to £35 5 0	
Best Selected Ingots, d/d Birmingham	£35 0 0	
Sheets, Hot Rolled	£62 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10d.	10d.
„ Brazed (basis)	10d.	10d.
Brass—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9½d.	9½d.
„ Brazed	11½d.	11½d.
Tin—		
Cash	£233 12 6 to £233 15 0	
Three months	£218 15 0 to £219 0 0	
Lead: Cash and forward	£15 7 6	
Spelter:	£14 3 9 to £14 1 3	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

Lanarkshire—	Export.
(f.o.b. Grangemouth)—Navigation Unscreened	13/– to 13/6
„ Glasgow—Ell	14/6
„ „ Splint	17/– to 17/6
Ayrshire—	
(f.o.b. Ports)—Steam	13/– to 13/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	13/6 to 14/–
Unscreened Navigation	13/– to 13/6
Lothians—	
(f.o.b. Leith)—Hartley Prime	12/6 to 13/6
Secondary Steam	11/9 to 12/–

ENGLAND.

Yorkshire, Manchester—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	13/– to 16/–
Northumberland, Newcastle—	
Blyth Best	13/6 to 14/–
„ Second	13/3 to 13/6
„ Best Small	10/6 to 11/–
Unscreened	12/6 to 13/6
Durham—	
Best Gas	14/8
Special Foundry Coke	19/– to 20/–

Sheffield—	Inland.
Best Hand-picked Branch	23/– to 25/–
South Yorkshire Best	20/– to 22/–
South Yorkshire Seconds	17/– to 18/6
Rough Slacks	8/– to 9/–
Nutty Slacks	7/– to 8/6

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Best Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Bunker Smalls	12/6 to 13/6
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	25/– to 40/–
Furnace Coke	19/– to 21/–
Patent Fuel	21/–
Swansea—	
Anthracite Coals:	
Best Large	36/– to 40/–
Machine-made Cobbles	41/– to 48/6
Nuts	40/– to 48/6
Beans	25/– to 30/–
Peas	19/– to 23/–
Rubbly Culm	11/– to 11/6
Steam Coals:	
Large Ordinary	18/– to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

French Engineering Notes.

(From our own Correspondent in Paris.)

Public Works.

THE decline of official unemployment figures is attributed by the Minister of Labour to an exodus of foreigners whose permits to work in this country have not been renewed, as well as to an increased activity at factories engaged in the production of material for national defence, the temporary extension of military service, and the putting in hand of public relief works. This last relief has not produced what was expected of it when the Marquet plan was heralded as a partial solution of the unemployment problem. The huge accumulation of social insurance funds, which were to have been drawn upon for the purpose, has been less readily available since the condition of national finance showed the necessity for prudence, but now that the Government is beginning to put things in order the Minister of Labour announces his intention of proceeding with the original plan of absorbing unemployed hands. There is no question of the State financing relief works. Money from the social insurance funds will be lent to responsible bodies for the execution of productive works under conditions that will allow of the money being repaid out of taxes, but the State will bear some part of the burden where undertakings are regarded as of national interest. Already a good deal of activity is being provided in Paris by the Metropolitan Railway extensions, water distribution, and preliminary works for the Paris Exhibition of 1937, and the railway companies continue to execute their programme of signalling and other equipment, but the ports complain of their inability to obtain financial aid for harbour improvements and installations, such aid being refused, in one instance, by the Government. So far as unemployment goes the situation should be further alleviated if the Government succeeds in its efforts to put national finance on a sound basis, but this can have little effect on the general activity, which depends upon a recovery of international trade. The construction of the aqueduct to bring a million cubic metres of water a day from the Vals de Loire to Paris is being delayed through the Government temporarily withholding the decree authorising the Paris municipality to issue a public loan for the purpose.

The Motor Car Industry.

The production of touring cars and lorries in France can only be estimated approximately from an analysis of statistics relating to licences, exports, and imports of cars and of parts for assembling, and on that basis the production in 1934 is given at 187,021 vehicles, or about 2200 less than in the previous year. Since the beginning of the present year it has become increasingly evident that the foreign trade, which formerly constituted the principal source of automobile activity, can no longer be relied upon unless special efforts are made to give further publicity to French cars. The most valued publicity is that provided by speed performances, in which French makers have failed to distinguish themselves in competition with foreign cars specially built for racing. At a time when makers have to exercise strict economy the trade cannot afford to construct special cars for racing and speed tests, and an attempt is therefore being made to raise the necessary funds for the purpose by public subscription, so that a suitable car can be produced to compete in international events. The home market, too, needs stimulus, and it is proposed to create a national type of cheap two-seater car travelling up to 50 m.p.h. and consuming no more than 5 litres of petrol per 100 kilom., which is approximately 60 miles to the gallon. The price of the car must not exceed 8000f., or about £106 at the present rate of exchange. The Society of Automobile Engineers has invited its members to submit ideas for such a car. These appeals to the public and to automobile engineers and manufacturers confirm the present tendency to organise the motor car industry in a manner to reduce charges and eliminate excessive competition.

A New Construction Dock.

Until the Chantiers de Penhoët constructed the lock, which can be used also as a graving dock, at its yard at Saint-Nazaire to permit of the "Normandie" being towed out into the Loire, there were no facilities for building ships longer than those afloat at that time, and the "Dunkerque" had recently to be removed from the construction dock at Brest to be completed by the addition of about 35ft. to the hull. In view of the construction of 35,000-ton battleships, the Chantiers de la Loire is preparing to lay out a new form of construction dock at Saint-Nazaire in which ships can be built either on the stocks or in the dock. Communication with the Loire will be by sluice gates. The stocks will be so arranged that if a ship is too long to be built entirely on them the dock will be filled to float it off into the basin, where it will be completed as in a construction dock. In this way it will be possible to build ships of any length that are likely to be required in the future. The estimated cost of the work is about 30 million francs. If the Government's plan to rationalise the industry by an amalgamation of the Penhoët and Chantiers de la Loire yards is carried into effect, Saint-Nazaire will become the centre of big ship construction.

Coal.

The production of coal and lignite in France during the first half of the year was 23,426,007 tons, a decline of 1,241,000 tons compared with the first six months of 1934. The number of men employed at the collieries at the end of June was 225,463, or 10,375 less than a year ago. Considering the heavy fall in coal consumption as a result of the industrial slump, the colliery industry has not suffered so much as might have been expected, except for a further drop in prices, and the situation of coalowners has only been saved from a possible collapse by the import quotas, which the companies, nevertheless, complain are not applied with sufficient stringency. During the peak of its prosperity the colliery industry in the Nord and the Pas de Calais was producing about 50,000,000 tons a year, so that in view of the unparalleled depression the present output cannot be regarded as abnormally low.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

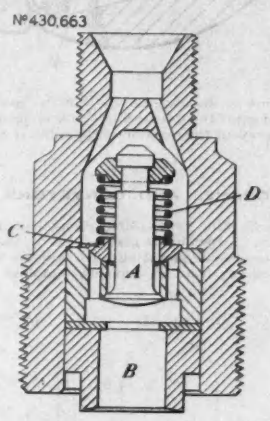
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

430,663. December 22nd, 1933.—FUEL INJECTION PUMPS, Simms Motor Units, Ltd., Percy Buildings, Gresse-street, Rathbone-place, London, W.1, and R. L'Orange, Stattler-strasse 25, Stuttgart, Germany.

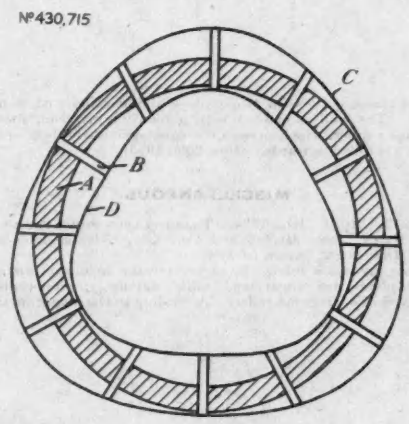
In order to prevent a dribble through the fuel injection jet



during the intervals between injection, the pressure in the delivery pipe is relieved by a small valve A opening inwards to the pump barrel B. This valve is arranged concentrically to the main delivery valve C and both valves are seated by one spring D.—*June 24th*, 1935.

430,715. January 26th, 1935.—ROTARY COMBUSTION ENGINES, Hannoversche Motoren G.m.b.H., of Podbielskistrasse 292, Hannover, Germany.

This rotary engine works on the six-stroke cycle. That is to say, the working and exhaust strokes are followed by two cooling strokes and two suction strokes. The machine comprises a rotary cylindrical piston A, through which sliding vanes

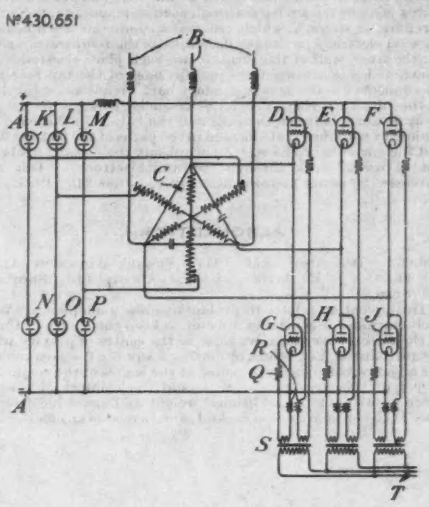


B pass. These vanes contact with the outer casing C and inner casing D, and provide two series of working compartments. Each compartment is provided with a sparking plug. It will be readily followed how the approximately triangular form of the casing gives the six-stroke cycle. The specification gives a considerable amount of constructional detail.—*June 24th*, 1935.

TRANSFORMERS AND CONVERTERS.

430,651. November 16th, 1933.—CONVERTING ELECTRIC CURRENT INTO POLYPHASE, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.*

This invention is concerned with apparatus for transmitting energy from a direct current supply to an alternating-current circuit. The direct-current supply is indicated at A A and the three-phase circuit at B. The apparatus comprises a three-phase, star-connected inductive network, the phase windings of which are connected with the positive side through electric valves D E F and to the negative side through other valves G H J. The networks are wound on a polyphase core, and are provided with a delta tertiary winding in order to maintain their voltages in polyphase relation. Each of the windings is extended beyond the neutral point to form auxiliary windings which are independently loaded for providing for circulating current in the network. This circuit comprises two more groups of valves K L M and N O P. In order to render the group of electric valves D—F alternately conductive and non-conductive in the proper sequence, the grids of the pairs of valves D—G, E—H, and F—J are connected to their respective cathodes through current-limiting resisters Q, negative bias batteries R, and independent secondary windings of the grid transformers S, the primary windings of which are connected to the proper phases of an alternating-current circuit T supplied with an alternating potential of a frequency at which it is desired to energise the alternating-current circuit B. The grid transformers are preferably designed to operate self-saturating in order to supply alternating potentials of peaked wave form to the grids of the several valves. In case it is not necessary to operate the circuit B at any predetermined frequency, the above-described apparatus may be connected for

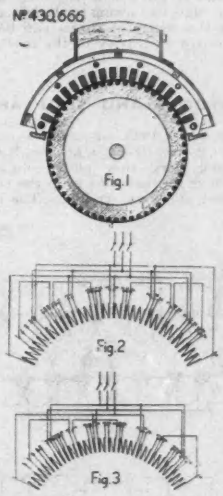


self-exciting operation by connecting the circuit T directly to the circuit B through any suitable phase-adjusting means.—*June 17th*, 1935.

DYNAMOS AND MOTORS.

430,666. December 23rd, 1933.—MOTORS FOR DRIVING MACHINE TOOLS, P. A. Fridkin, U.I. Lenina 1, log. 2, Leningrad, Russia.

This invention aims at providing a polyphase electric motor having several speeds for driving machine tools. Fig. 1 shows plainly the rotor and the stator, which is only a segment of a

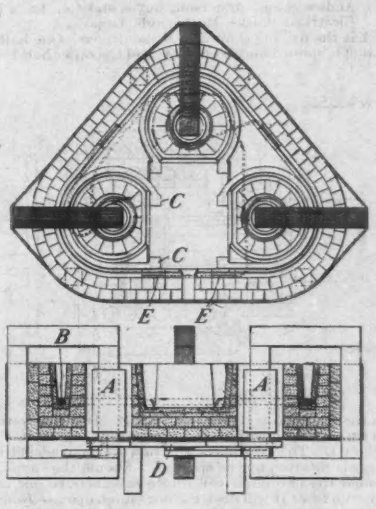


circle. Each phase of the stator winding is sectionalised and tappings are taken off, as shown in Figs. 2 and 3, to a switch. In this way, the pole pitch of the stator can be altered, and, consequently, the speed of the machine. The arrangement of connections shown in Fig. 2 gives the lowest speed possible, while in Fig. 3 the speed is increased by one-third, and so on.—*June 24th*, 1935.

FURNACES.

430,667. December 23rd, 1933.—INDUCTION FURNACES, T. J. Salter, 1406, G-street North-west, Washington, Columbia, U.S.A.

This induction furnace is approximately triangular in plan



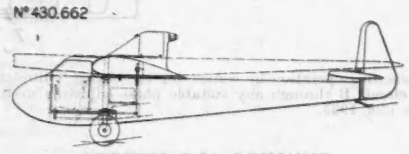
with three single-phase primary windings A at the corners. The secondaries comprise heavy bars B with extensions C C at their ends, which are embedded in the floor of the hearth and are covered by the molten metal. The metal does not, however

rise sufficiently high to cover the secondary bars. Each transformer has a second secondary D, in the form of a conductor which is wound around the lower end of the inner vertical leg of its core. These secondaries have terminals or electrodes E formed of steel plates embedded in the side walls and covered with a layer of refractory material, such as magnesite, dolomite, chromite, or zirconia, which becomes a conductor when heated, since its electrical resistance decreases as the temperature rises. On the front wall of the furnace two such plate electrodes are shown as being arranged at opposite sides of the tap hole and are connected to the same secondary bar. In induction furnaces of the ring type there is a large magnetic leakage due to the great distance between the coils and the bath. In this case the secondary windings D are located in the paths of the leakage lines and the currents produced by neutralising the leakage fields are put to useful work through the wall electrodes. This also increases the power factor considerably.—*June 24th*, 1935.

AERONAUTICS.

430,662. December 22nd, 1933.—Pusher Airscrew Aeroplanes, L. E. Baynes, of E. D. Abbott, Ltd., Farnham, Surrey.

This invention relates to pusher airscrew monoplanes. With such machines it is usually difficult to keep the centre of thrust of the airscrew or airscrews close to the centre of gravity without introducing tail booms or cutting away the fuselage to clear the airscrew when one is provided at the centre of the span. The object of this invention is to secure the comfort of a cabin machine without the additional weight and extra head resistance of the ordinary cabin cockpit, and to enable an efficient and



compact pusher machine to be constructed having a low centre of thrust without the use of tail booms and without cutting away the body. Accordingly the monoplane has wings of thick section mounted on the top of the body behind the cabin and the top of the cabin is faired into the top of the wing profile so that the trailing edge of the thick section wing is brought appreciably below the cabin top. The engine and airscrew are mounted above and to the rear of the wing with the airscrew above the trailing edge, and owing to the latter being below the top of the cabin the centre of thrust can be brought low in relation to the centre of gravity of the machine.—*June 24th*, 1935.

MACHINE TOOLS AND SHOP APPLIANCES.

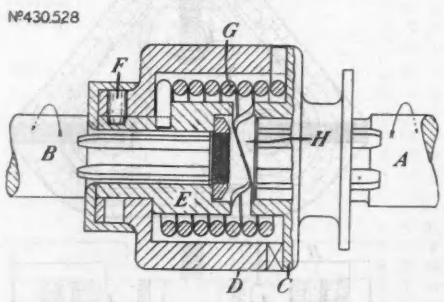
430,725. March 20th, 1935.—Plate-straightening Rolls, *F. W. Le Tall*, 2, *Norfolk-street, London, W.C.2.*

In straightening very thin plates—for instance, below 0·4 mm. thick—it is necessary to keep the straightening rolls very close together and very straight. The inventors suggest

rolls of 40 mm. diameter spaced at 41 mm. centres. These rolls are backed up by stiffening rolls. The two classes of roll are marked A and B respectively. Spacing rolls C, of 22 mm. diameter, are placed in the interstices and are supported on stools D.—*June 24th*, 1935.

430,528. March 21st, 1934.—Overload Slip Couplings, A. Anderson and Anderson, Boyes and Co., Ltd., Flemington Electrical Works, Motherwell, Lanark.

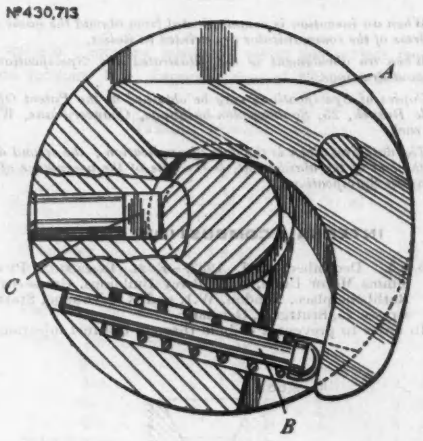
A is the driving shaft and B the driven. One half C of a dog clutch is splined on the shaft A, and the other half D is mounted



on the sleeve E keyed to the shaft B. D is free to turn on E to an extent dependent on the engagement of the pin F with a slot cut in E. The two parts are, however, connected together as regards rotation by the spring G. Should the coupling be overloaded the two parts will rotate relatively to one another and the cam faces H will push the dog clutch open.—*June 20th*, 1935.

430,713. January 14th, 1935.—Shaft Collars, Sir A. Herbert, A. H. Lloyd, and W. S. Fielding, Canal-road, Edgwick, Coventry.

This is a collar for holding such objects as change gears endways on splined shafts. On the shaft there is cut a groove in which the trigger A engages when the collar is in place. The trigger is pressed into engagement by the spring B, but the

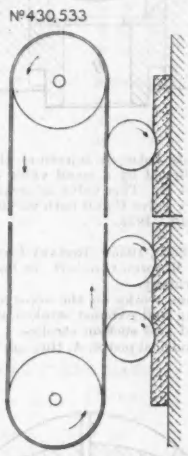


essential feature of the invention is that the trigger is so proportioned that centrifugal force tends to keep it in engagement. C is a key to prevent the rotation of the collar if desired.—*June 24th*, 1935.

CRANES AND CONVEYORS.

430,533. April 18th, 1934.—Elevators for Tin Cans, E. Southgate, 22, Devonport-gardens, Ilford, Essex.

For the purpose of elevating such objects as cylindrical tin cans containing fruit, the inventor employs a continuous

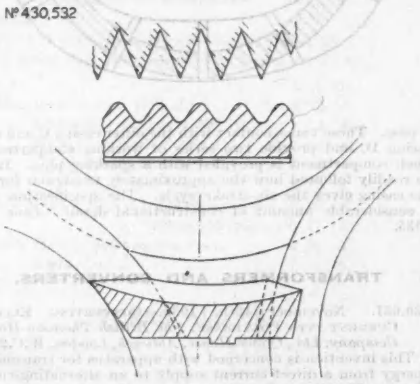


band running between two pulleys and parallel with a fixed wall. The wall is padded with a resilient material, such as sponge rubber, which presses the cans against the belt so that they are rolled upwards.—*June 20th*, 1935.

MISCELLANEOUS.

430,532. April 11th, 1934.—Trash-plates for Sugar-cane Mills, *John McNeil and Co., Ltd., Colonial Ironworks, Helen-street, Govan, Glasgow.*

This invention relates to improvements in dumbturners or trash-plates for sugar-cane mills having circumferentially grooved or corrugated rollers. According to the invention there



is formed in the upper surface of the dumbturner plate a series of transverse grooves extending the entire width of the plate and mating with the ridges in the top roller. With the described arrangement the bagasse which is crimped in its passage between the top roller and the feed roller retains the crimped form until its discharge between the top roller and the discharge roller.—*June 20th*, 1935.

431,054. December 22nd, 1933.—Aluminium-Magnesium Alloys, I. G. Farbenindustrie Aktiengesellschaft, Grüneburgplatz, Frankfurt-on-the-Main, Germany.

This invention relates to alloys containing both aluminium and magnesium, one or the other of which forms the predominant constituent of the alloy, and which are free from any intentional addition of silicon. The invention relates to alloys which contain at least 3 per cent. of magnesium, but a preferable range of application, from a technical point of view, is constituted by aluminium base alloys containing from about 3 per cent. of magnesium up to about 20 per cent., and by magnesium base alloys containing from about 0·5 per cent. up to about 20 per cent. of aluminium. Up to a total of 1·5 per cent. of one or more other elements, such as manganese, zinc, and calcium, whether deliberately added or only contained therein as impurities, may also be present in the foregoing alloys without substantially influencing the effect of the treatment according to the invention. In order to prevent corrosion from taking place the alloys, after cold working, are, according to the invention, subjected to an annealing treatment under such conditions of temperature and duration as to preclude recrystallisation. The temperature as well as also the duration of the treatment necessary for fulfilling the purpose of the invention vary according to the composition of the alloy and the nature of the preceding treatment by cold working, within certain moderate limits. As a rule, heating of the alloys or work pieces to about 150 deg. to 200 deg. Cent., for a period between about one and about two hours has proved suitable. The effect of cold working on a metal work piece is to modify its crystalline structure by slipping and/or twinning of the individual crystals. The more extensively the crystalline structure is modified by cold working, the stronger is the tendency of the material to recrystallise, and therefore the shorter must be the duration, and/or the lower the temperature of annealing, in order to avoid recrystallisation. The following are two embodiments of the process of the invention:—Example 1: An alloy containing 7 per cent. aluminium, 1 per cent. zinc, 0·3 per cent. manganese, balance magnesium, was rolled into 1 mm. sheet by the usual hot-rolling process, the final pass, reducing the thickness by a further 10 per cent., being effected in the cold. The sheets were then subjected to a thermal treatment at 160 deg. Cent. for two hours. Example 2: Sheets of 1 mm. thickness were produced in a similar manner from an alloy containing 9 per cent. magnesium, 0·5 per cent. manganese, balance aluminium, and then subjected to a thermal treatment for 1½ hours at 190 deg. Cent.—*June 24th*, 1935.

430,668. December 23rd, 1933.—Flexible Hose for High-pressure Hydraulic Braking Systems, Automotive Products Company, Ltd., Brock House, Langham-street, London, W.1.; E. B. Boughton, Fabriche Riunite Industria Gomma Torino, Via Verolengo, 28, Turin, Italy, and R. Laguidara, Via Verolengo, 28, Turin.

It is pointed out that in high-pressure hydraulic braking systems for motor vehicles it is necessary to make some of the connections flexible, but the connections must not be subject to

appreciable changes of internal volume, otherwise the brakes will not function properly. The inventors consequently use a hose reinforced with rubber-coated threads as shown in the illustration—that is to say, there are four layers of reinforcement, one wound left-handed, two wound right-handed, and the fourth left-handed again. The whole is covered with a vulcanised rubber sheath. The inventors say that this construction is much better than a braided covering.—*June 24th*, 1935.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

The Metropolitan-Vickers Electrical Company, Ltd., advises us that both its London office and the offices of its export company are removing from Bush House and that on and from August 6th the London office address will be Metropolitan-Vickers Electrical Company, Ltd., 1, Kingsway, London, W.C.2.

Mr. Peter Alexander McKillop, who for the last thirty-five years has represented the Vacuum Oil Company's interests in Scotland, has retired from that position. Mr. McKillop is a member of the Institute of Engineers and Shipbuilders, the Institution of Electrical Engineers, and the Institute of Mining and Electrical Engineers.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2, has been entrusted by the owners of the Cunard White Star liner "Queen Mary" with the manufacture and supply of the whole of the lighting fittings for use in the first-class dining saloon, the ballroom (including a colour changing scheme), the smoke room, the main lounge, the forward observation lounge and cocktail bar, the starboard gallery, and the long gallery.

The Neckar Water Softener Company, Ltd., of Westminster, has received an order for a water treatment plant from Clarke, Chapman and Co., Ltd., for the Slough Estates, Ltd. The plant is to treat well water so as to render it suitable for feeding to boilers of 600 lb. pressure. A Neckar deaerator is incorporated to deaerate the total boiler feed. For controlling boiler water concentrations and regaining heat from the blow-down the Neckar continuous blow-down system with a heat exchanger is included.

CATALOGUES.

Turbine Gears, Ltd., Cheadle Heath, Stockport.—An illustrated loose-leaf booklet on gears and gear units.

Crompton Parkinson, Ltd., Bush House, Aldwych, W.C.2.—An illustrated booklet dealing in a general way with Crompton switchgear.

Pegson, Ltd., Coalville, Leicestershire.—A folder on the firm's power rammer, a self-contained unit incorporating a petrol engine.

Evershed and Vignoles, Ltd., Acton-lane Works, Chiswick, W.4.—A new publication dealing with electrically operated recording instruments.

London Electric Wire and Smiths, Ltd., Playhouse-yard, Golden-lane, E.C.1.—Particulars of the firm's new product, "Lewcos" enamel and single paper covered wires.

G. A. Harvey and Co. (London), Ltd., Woolwich-road, S.E.7.—Catalogue No. 650, a volume of over 600 pages giving detailed lists, illustrations, and in many cases prices of the firm's products.

Stewarts and Lloyds, Ltd., King's-buildings, Dean Stanley-street, S.W.1.—The following recently issued catalogues:—"Tubular Steel Coils," "Steel Pipes for Water and Gas," "Steel Tubes in the Public Service."